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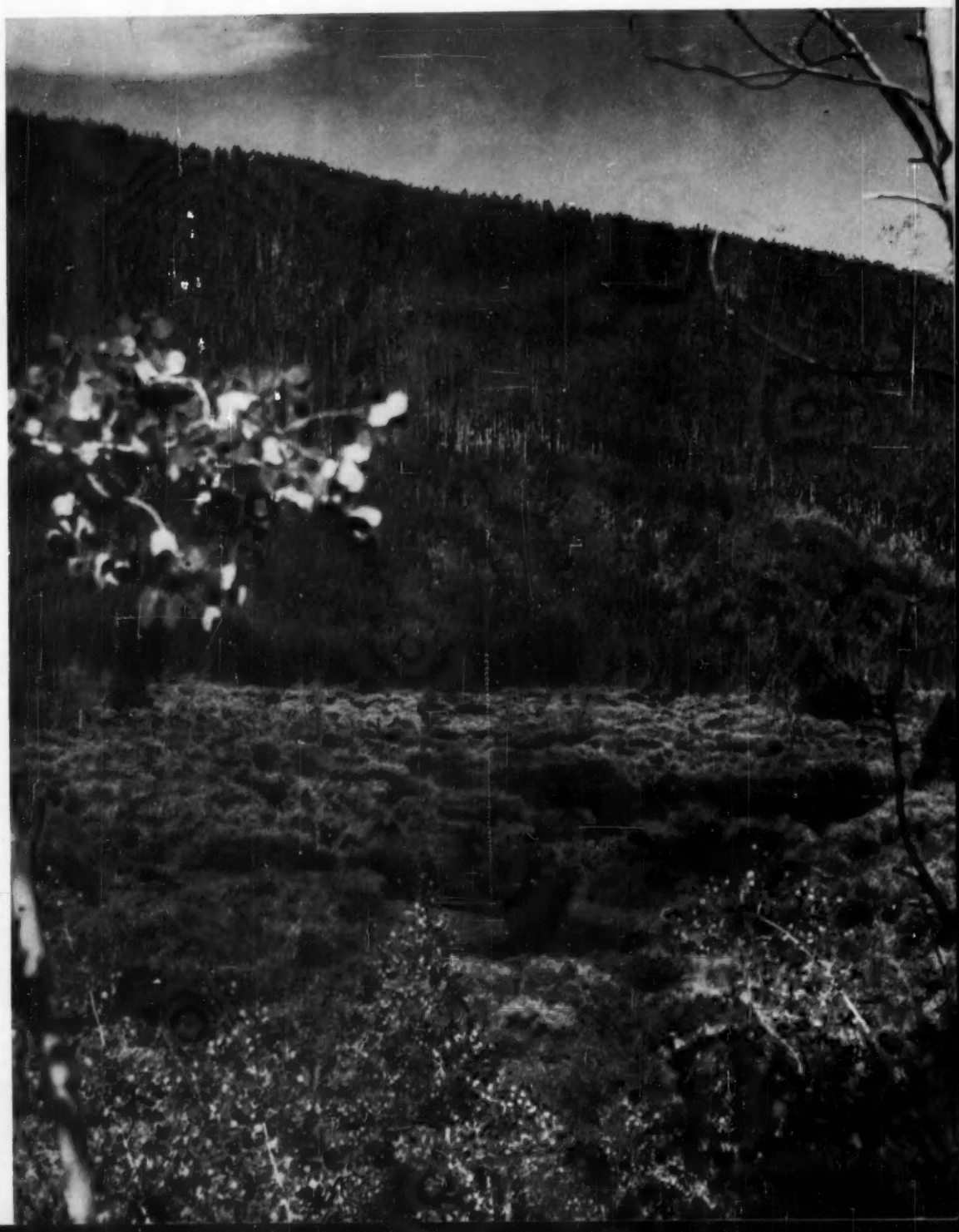

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CONTENTS

COVER: Typical beaver-meadow on North Fork of Williams Fork River, Colorado. See page 803.

Wildlife and Environmental Relationships of Beavers in Colorado Forests — *William H. Rutherford* 803

Methods of Detecting and Removing Bullets and Shell Fragments from Saw Timber Located on Military Lands — *Keith D. Lange* 806

Methyl Bromide Fumigation of an Illinois Nursery Soil — *Hugh B. Wycoff* 811

Empirical Volume Tables — *Harold E. Young* 814

Forest Growth Goals in a Private Enterprise Economy — *G. Robinson Gregory* 816

Effects of Diameter, Crown Ratio, and Growth Rate on Gum Yields of Slash and Longleaf Pine — *C. S. Schopmeyer* and *P. R. Larson* 822

Seasonal Distribution of Radial and Leader Growth in the Sitka Spruce-Western Hemlock Forests of Southeast Alaska — *Richard M. Godman* and *Robert A. Gregory* 827

Reproduction of Upland, Cutover Spruce—Balsam—Hardwood Stands in Minnesota — *C. E. Olson, Jr.* and *R. R. Bay* 833

Grafting Slash Pine in the Field and in the Greenhouse — *François Mergen* 836

Notes 843

Survivals and Heights of Various Grades of Red Spruce Transplant Stock; Response of Black Locust to Phosphate Fertilizer; Bitterlich's "Spiegelrelaskop"—a Revolutionary General-use Forest Instrument; Seedfall and Cutting Systems in Texas Shortleaf Stands; Repeat Burns Reduce Small Stems in Texas Big Thicket.

Points of View 848

Some Comments on Fire Law Enforcement in the South.

Reviews 854

Wood Handbook; Tree Planting Practices for Arid Areas; Cunningham and Reed's Guide to Earning a Living; The Forester's Companion; Trees and Shrubs of the Upper Midwest; Publications of Interest.

Current Literature 860

Society Affairs 862

Forestry News 873

Index to Advertisers 880

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Wildlife and Environmental Relationships of Beavers in Colorado Forests[1]

William H. Rutherford
Colorado Game and Fish Department, Denver

IT IS UNIVERSALLY known that the beaver (*Castor canadensis*) has increased markedly in numbers over most of its range during the last two or three decades. It is likewise well known that this mammal, more than any except man, is capable of inflicting change in its environment, thereby affecting the well being of associated forests, fish and wildlife. As a factor, therefore, in both the economics and ecology of its environment—forest-bordered waters—the beaver is now looked upon by forest managers with feelings ranging from welcome to requests for control or even extirpation.

The more obvious of the beaver's ecological relationships, principally its influence upon associated wildlife, have been recognized by such authorities as Bradt (*1*), Cook (*2*), Grasse (*3*), Hodgdon and Hunt (*5*), Rasmussen (*6*), Scheffer (*7*), and Seton (*8*). It is less well known that environmental factors over which beavers have no control may affect profoundly the initial development and stability of beaver populations, and hence their faunistic affinities. Chief among these are forest fires and geological influences.

In an effort to evaluate this two-way wildlife-environmental relationship, Colorado biologists, during the last three years, have engaged in field investigations on a large number of streams in this state. At first, the work was designed as a relatively intensive investigation of beaver-wildlife interrelationships on the Williams Fork River in Grand County, a watershed rising immediately west of the Continental Divide. Through association with Dr. John L. Retzer, soil scientist, and other members of the Rocky Mountain Forest and Range Experiment Station at Fort Collins, the scope of study was broadened considerably in 1954, and it is now felt that some insight has been gained on this latter phase—the role of the environment upon the beaver.

TABLE 1.—GROSS PHYSICAL COMPARISON OF THE NORTH AND SOUTH FORKS OF THE WILLIAMS FORK RIVER, GRAND COUNTY, COLORADO

Feature	North Fork	South Fork
Length (main stream only)	13.0 miles	11.5 miles
Drainage area	35.8 sq. miles	26.8 sq. miles
Valley flood plain area	1,077.0 acres	908.3 acres
Water surface area:		
Stream	24.4 acres[1]	13.2 acres[1]
Beaver ponds	42.0 acres	9.7 acres
Elevation:		
Headwaters	11,240 feet	10,950 feet
Confluence	8,905 feet	8,905 feet
Average gradient	196 ft./mile	176 ft./mile
Volume flow (spring)	285 cu.ft./sec.	260 cu.ft./sec.
Volume flow (late summer)	46 cu.ft./sec.	39 cu.ft./sec.
Major cover types in valley:[2]		
Spruce-fir	174.9 A.; 16.2%	540.1 A.; 59.5%
Willow-sedge meadow	498.3 A.; 46.3%[3]	239.5 A.; 26.4%[3]

[1]Difference due mainly to flattening out, widening, and meandering caused by past beaver activity on North Fork.

[2]Percentages based on total valley area, to which water surface and minor cover types must be added to give 100 percent.

[3]Includes only the meadow types currently or formerly beaver-influenced.

Area and Methods

The Williams Fork River investigation involved the selection of two streams as nearly alike as possible as to watershed area, stream flow, gradient, valley width, and general topographic features. The North Fork was selected as the beaver-occupied stream, and the South Fork, its main headwaters tributary, as the control stream. Choice was made of these two streams, despite the presence of small numbers of beavers on the willow-bordered upper reaches of the South Fork; it is almost impossible to find sizeable watersheds in Colorado not presently influenced by these animals. Gross comparison of the two study streams is given in Table 1.

The effects of beavers upon other wildlife were determined by comparing statistically, by species, the numbers of animals seen in 333 15-minute observations on beaver-influenced sample plots with numbers seen in 409 15-minute periods on

[1]Adapted from a Master of Science thesis prepared under the auspices of the Colorado Cooperative Wildlife Research Unit at Colorado A & M College, Fort Collins. Acknowledgment is made to the Colorado Game and Fish Department for financial support during the summers of 1952 and 1953; to Dr. Lee E. Yeager, unit leader; Prof. J. V. K. Wagar, Colorado A & M College; and Mr. Laurence E. Riordan and Mr. Paul Gilbert, Game and Fish Department, for supervision and consultation through the course of investigation; and to the U. S. Forest Service, through Mr. Robert Dunstan, district ranger, for many courtesies and the use of aerial photographs.

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non-influenced plots. These data were supplemented by winter-sign transects, wherein the numbers of animal tracks intersecting established lines, located in beaver-influenced and non-influenced areas, were recorded following each snowfall. Vegetative measurements, to determine the effect of beaver impoundments upon forage growth, were also made.

Observation-plot data were tested by using Student's Generalized Hypothesis and Test, with rejection of the hypothesis if the mean figures under consideration were found to differ in sufficient degree at the .05 level of significance. In many comparisons, especially those involving an appreciable number on one series of plots as against zero for another series, significance was immediately apparent, and no analyses were made.

In testing winter track-count data, it was hypothecated that the number of tracks counted on each of two compared transects was equal. The chi-square test was applied, with rejection of the hypothesis if the observed values differed too greatly from the expected values.

Relative vegetative, or forage, production was determined by using both line transects and sample plots. Vegetation was measured by length and volume on beaver-influenced and non-influenced areas. These data were not suitable for statistical analysis, or for projection to determine production per unit area over the entire area considered, but were compared by gross examination to indicate the relative annual vegetative growth and volume.

Wildlife Relationships

The following paragraphs summarize wildlife relationships determined during 1952-1953, the first two years of the investigation.

Big game.—No significant difference between big-game populations on the two watersheds could be determined from sample-plot data, due to the large cruising radius of these animals. Increased forage production in beaver-influenced valleys probably offered the most reliable index to the influence of beavers upon big-game animals. However, because the streams at the point of study involved summer range only, it is believed that the greater forage production of beaver-pond areas may be of limited benefit, since there is no shortage of summer range for deer and elk. Beaver workings on winter range, always at lower elevations, are undoubtedly of greater value to big game than those on summer range.

Waterfowl. — Ducks inhabited beaver ponds, used them, and nested near them to the complete exclusion of all other water types in the area involved. In 1952, 9.4 young ducks per square mile, and in 1953, 16.2 per square mile, were produced. Absence of beavers on the area would have resulted, apparently, in the absence of waterfowl. When it is considered that there are about 20,000 square miles of national forest land in the higher elevations of Colorado, it can be readily understood that production, no matter how small per square mile, becomes considerable when projected. Thus, Grieb, *et al* (*4*), reported duck production of 6.1 to 6.8 young per square mile on the White River Plateau of northwestern Colorado, and estimated that waterfowl production from high-country areas in the state might approach 100,000 birds annually. Mallards and green-winged teals are the principal species.

Muskrat. — Muskrat occurrence, although significantly greater on beaver-influenced sites, was not high at any location. It is believed that the absence of air space between ice and water during winter is largely responsible, and that, while beaver occupancy of high-altitude streams generally results in increased muskrat production, the rigors of winter are so limiting that the increase is scarcely significant.

Snowshoe hare. — Analysis of winter-use data showed that snowshoe hares preferred the "edge zone"—the meeting of beaver meadow with lodgepole pine— over the pure lodgepole pine type; in spruce-fir, they preferred the higher ground away from the stream over the lower streamside terrain; and finally, they preferred level timbered terrain over steep timbered hillsides. Thus, beavers, by creating openings in forests, thereby adding to the amount of "edge," may make the habitat more attractive to snowshoe hares. However, since forest types, especially spruce-fir, are highly preferred over beaver meadows, removal of a part of a type appears to cancel any beneficial effects introduced by "edge" creation.

Weasel family.—The preference exhibited by minks for beaver-pond areas is probably due to the concentrations of fish and small mammals in and around the ponds. For martens, it is believed that removal by beavers of a part of a forest type, through drowning of conifers, has no material effect over the entire watershed because the area affected (the valley bottom) is comparatively small. No influence by beavers upon weasel populations could be determined.

Dog family.—The presence of beavers in a watershed appeared to exercise no material influence on the occurrence of coyotes or foxes.

Blue grouse—As in the case of the marten, it is believed that no significant decrease in the habitat of blue grouse occurs as the result of beaver occupancy of valley bottoms.

Pine squirrel.—Beaver occupancy, of course, creates a habitat type highly unsuitable for the pine squirrel. As for martens and blue grouse, however, it is believed that the small amount of habitat thus removed from a watershed has no material effect upon the population level of these animals.

Non-game birds.—No significant difference in non-game bird occurrence between beaver-occupied and non-occupied plots was found.

Trout.—It was determined by statistical analysis that brook trout taken from beaver ponds were significantly longer than those taken from the stream, but the ratio of length-to-weight, expressed as the *K* factor, averaged significantly larger for stream trout. It appeared that relatively new beaver impoundments provide food and cov-

er conducive to greater numbers and volume production of brook trout than streams, but that older ponds (solely employed in this study), through habitat deterioration, over-population, or both, tended to produce the poorer conditioned trout. This situation is believed to apply to most "old" beaver ponds on high-altitude streams in Colorado.

Effects of Environment upon Beavers

As previously indicated, the selection of study streams in the Williams Fork drainage was based on the need for a beaver-occupied stream and an unoccupied stream to serve, respectively, as study and control areas. This requirement was satisfied reasonably well through the selection of the North Fork, with its abundant beaver food on and adjacent to the valley bottom; and the South Fork, characterized by the very limited quantity of beaver food present.

In general, the important ecological difference between the two watersheds is due to fire. On the North Fork, the beaver-occupied stream, slopes above the floodplain are covered to a large extent by a second-growth "burn forest" of aspen, lodgepole pine, and varying mixtures of the two. Several of the largest and oldest of these second-growth trees were felled to permit counts of annual growth rings, the largest number so recorded being 62. On this basis, the elapsed time since the last killing fire was conservatively estimated at 70 years.

This fire, with its subsequent growth of aspen, undoubtedly accounts for the presence of beavers in far greater numbers than on the control stream. Once the animals became established, their dam- and pond-building activities resulted in the formation of a typical, high-altitude, willow-sedge wet meadow. Continued occupancy of the valley bottom has maintained this meadow because the high water-table so induced precludes the re-establishment of coniferous trees. It is believed that the entire floodplain would be covered by the same type of second-growth "burn forest" now on the adjacent slopes had it not been for continued beaver activity during subsequent years. On the valley floor, glacial action has left numerous high spots (moraines, hummocks, and other depositions) with surfaces several feet higher than the surrounding water table. Coniferous trees have become re-established on these higher, and therefore drier, sites.

The valley of the South Fork, the check stream, contains only one major area of beaver occupancy. This is a relatively flat meadow formed as a result of deposition behind a glacial terminal moraine, wet enough to support abundant willow growth. Beavers have occupied this meadow off and on for many years, subsisting on the willows. Indications are, however, that the beaver population here has never been large. Data accruing from this occupied locality are excluded from that pertaining to the control stream.

With these observations on the Williams Fork River as a basis, the writer has studied many Colorado high-country streams in a similar manner. Numerous examples of the effects of topography and forest fire upon beaver populations have been observed, and almost invariably the pattern has been that initial beaver occupancy was wholly, or in large part, dependent upon these influences.

Excessive stream gradient is a major deterrent to permanent beaver occupancy, regardless of the quantity of food present. In many instances it was found that where glacial depositions had "flattened out" a portion of a stream originally having a general gradient of 10 to 15 percent or more, the presence of beavers was limited to this portion, even though plant succession following fire had resulted in a profusion of aspen along the steeper stretches of the stream. Conversely, very little evidence of beaver occupancy was found on streams where fire had not occurred, regardless of the gradient. In general, few instances of permanent beaver occurrence were found on any stream having a gradient in excess of 8 percent.

The presence of certain rock and soil types in valley bottoms precludes permanent beaver occupancy, regardless of stream gradient or food conditions. It was found that many valleys having soils from shales or granitic rocks are subject to such severe erosion that beaver impoundments here have very short life expectancies due to rapid deposition and filling of the ponds. It is possible that beavers in such valleys may aggravate this unstable condition because when their dams deteriorate, the breach is usually at one end, inducing cutbank erosion which may remove greater quantities of soil than held behind the dams. The influence of soil type upon beaver occupancy was discussed by Yeager and Hill (*9*), who have studied and reported on the ecological effects of food exhaustion and subsequent abandonment of small, high-country watersheds by beaver populations.

Management Applications

The beaver's role in the management of high-country forests in Colorado, as determined to date in three years of field study, may be subjected to the following considerations:

1. Under sustained-yield management, and on streams of suitable gradient and soil characteristics, beavers exert beneficial influences upon wildlife, fish, forage, and the watershed. On such waters the permanency of benefits appears to be directly proportional to management resulting in careful control of beaver populations.

2. There appears to be many small streams, usually at high altitude, on which beavers may initially be desirable, but which can never sustain these animals because of physical incapacity, especially in regard to gradient and food.

3. There appears to be many other streams, variable in size and altitude, capable of supporting beavers for a time, but which should never be so occupied because induced erosion and soil instability will ultimately result in losses greater than benefits.

4. Beaver populations must be controlled in keeping with sound ecological principles, aside from

control that may be required for economic reasons. The ecological management of beavers should be, preferably, on a watershed basis, and executed on information derived from specific appraisals of food, water, soil, and topographic potentials or characteristics.

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Methods of Detecting and Removing Bullets and Shell Fragments from Saw Timber Located on Military Lands

Keith D. Lange[1]

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TRACTS of timber on military reservations composed of trees containing bullets and shell fragments are marked for sale in one of two ways. If a percentage of the trees of merchantable size contain metal, the stand damage is classified "heavy," and the area is by-passed by the marking crews. If the damage classification is "light," the timber is marked but the purchaser usually scans the logs at the mill with an Army mine detector and removes the damaging metal before the log is sawed. If it is of non-damaging nature he usually ignores it.

The amounts of military metal in timbered tracts vary considerably. One tract may have been the former location of a pistol range, and contain large quantities of lead bullets, whereas the next tract may contain only occasional 50-calibre bullets, and still another tract may be damaged by shell fragments. The location of the metal particles, the frequency with which they occur in the trees, and the kind of metal are usually unpredictable. The general appearance of the trees in certain stands suggests the presence of metal. For example, in pine trees, pitch pockets and small unhealed wounds are indicators of metal penetration. Live trees with missing tops, large branches and large areas of bark, and splintered trunks indicate the use of heavy calibre ammunition and the possibility that shell fragments are present in the trees.

Review of Literature

Although a limited number of reports have described the use of mine detectors by secondary wood-using industries, review of the literature has disclosed no comprehensive investigation of the use of detectors under the conditions present on a military installation where the metal encountered is largely in the form of bullets and shell fragments. Brundage (*1, 2*) has described a technique in detecting hidden metal in wood with the SCR-625 Army mine detector. Walters (*3*) has also described successful tests made with the SCR-625-H in locating ferrous metals in logs and unsuccessful use of the detector in locating lead. The AN/PRS-1 detector also was tested and found unsatisfactory.

The Study

The purpose of this study was to determine first, the amount and type of metal present in a 600-acre stand of loblolly pine on one military reservation, and second, the feasibility and cost of locating such metal with Army mine detectors and removing it from logs before they reached the headsaw.

The area on which the test was conducted was composed of approximately 15 blocks of timber varying in size from 5 to 100 acres. Four of the 15 blocks contained 75 percent of the total acreage. The timber on about 80 percent of the test area was pure loblolly pine 35-40 years old. The remainder of the timber was mature to over-mature loblolly pine. The stands contained a scattering of hardwood trees. The study was designed to search trees on sample areas in all of the timber.

Although the best system of cutting probably would have been to select individual trees at random

[1]The author gratefully acknowledges the help and cooperation in this study of M. R. Brundage (retired), Central States Forest Experiment Station, U. S. Forest Service; Sgt. Edwin Thomas, U. S. Army Bomb Disposal Team; and Earl Biggs, lumber inspector, Corps of Engineers; and to C. S. Walters, associate professor of Forest Utilization Research, University of Illinois; Mark M. Lehrbas, chief, Forest Utilization Service, Southern Forest Experiment Station for their review and comments on the paper.

in a pattern which would have sampled the entire stand, the method was not used because it was economically impractical. Consequently, all trees 9 inches d.b.h. and larger were selectively marked and cut on strips 1 chain wide, through the four main bodies of timber. These strips were termed A, B, C, and D. The amount of timber to be cut on the test run was predetermined to be 100 M bd. ft. From previous ocular field checks, it was determined that certain areas had been used as firing ranges and that the trees were heavily contaminated. These areas were omitted from the sampling because it was assumed the trees contained more metal than would be economically feasible to remove in regular sawmilling operations. No distinction was made in the sampling of the two age classes even though it was suspected that metal of different type and amounts might be present in the older timber.

Military metal found on this study consisted of shell fragments, 50-calibre bullets, 30-calibre bullets, pistol and other small bullets. The shell fragments were steel. Pieces varied from the size of a pencil eraser to the size of a walnut. Fifty-calibre bullets had steel jackets and were about 2½ inches long and ½ inch in diameter; the centers were of steel, lead, alloy, and burned tracer residue. Thirty-calibre bullets were of several types; some were entirely lead, some were of alloy metal, some had a brass jacket with lead or alloy metal centers. They are about 1 inch long and 5/16 inch in diameter. Pistol and small arms bullets were small and of lead.

Equipment Used

The searching was done with two models of the Army SCR-625 mine detector; SCR-625-C and SCR-625-H. Both instruments are basically the same except that the SCR-625-H is a later model with some minor changes in component parts. The set is a miniature broadcasting and receiving set designed to locate anti-tank mines. It weighs 22 pounds in operating condition. The detectors consist of a search-head coil mounted on a rod which is connected to an amplifier and headphones. The amplifier with its dry batteries, tubes and other radio parts sets up an electronic field in the coils of the search-head when metal passes within the effective distance. The change in voltage as the metal is passed results in a change in the tone heard in the earphones. The size and character of the metal and its distance from the search-head determine the intensity of the tone. The SCR-625-H model does not have the indicator dial on the rod. Except for the rod, the parts of both instruments are interchangeable.

The instrument has a shoulder mounted resonator similar to a loud speaker. The resonator was not used because outside noises from machinery made hearing difficult and searching less accurate. The instruments are very sensitive to rough use and were therefore handled with extreme care at all times. They needed periodic mechanical maintenance and repair. With certain exceptions, a competent radio repairman kept sets in working order. On the test, small sheds were constructed for storage and as a cache for cant hooks, axes, saws, and extra detectors and parts.

Procedure

An exploratory study showed that the best place to search the logs would be at the sawmill just prior to sawing. However, before initiating full-scale searching study on decked saw logs, an exploratory test was made in the woods on standing trees, felled trees, and tree lengths to see if it was possible and practical to find and remove metal at these points.

On standing trees, a 12-foot butt log could be searched from the ground. It was assumed that this portion of the tree might contain most of the metal. On felled trees, the stems were cut so that the butt rested on the stump whenever possible to aid the searching of all four sides of the tree.

The searching of tree lengths and logs was done at a truck-loading point established in the woods. Tree-lengths were skidded to the landing with a tractor and two-wheeled cart. Tree-length pieces were scanned just prior to bucking. Any metal located was immediately marked and removed from the log. The entire piece was bucked into log lengths and pulled into a log pile some 50 feet away with power winch and cable where they were loaded onto trucks. Some of the tree-length pieces were bucked into logs and each log then was scanned. Any metal found in the logs was removed immediately, and the cleaned logs were moved to the truck-loading station with the winching equipment.

The final and full-scale searching study was done on the log deck at the sawmill site. All of the material cut for the study (Table 1) was harvested as saw logs. The logs were skidded from the four cutting strips to a central truck-loading point, where they were loaded on trailer trucks for delivery to a small portable sawmill with a circular headsaw. The logs were stored on an extended log deck 110 feet long, 20 feet wide, and 3 feet high. The deck was designed to provide 30 feet of storage space for logs to be searched, 30 feet of space for searching activities, and 50 feet of space for storing metal-free logs for sawing. These distances were found to be proper by trial and error. The searching area was filled in with dirt and later supplemented by planking, so that searchers would have a flat surface to work. The original design of the deck called for the construction of a side ramp 10 feet long perpendicular to the main deck and opposite the searching station. The ramp was to store logs containing metal when searching fell behind milling operations and those which the searcher wished to check-scan. The side ramp was not constructed, however, because experience showed it was not needed. To eliminate the interference resulting from trampmetal in the soil or from metal fasteners, no nails or other metal were used in the construction of that part of the deck where the mine detectors were used.

To further increase the efficiency of the detector operator by mini-

mizing the noise from the sawmill, a sound baffle approximately 12 feet high and 16 feet long was built of low-grade boards between the power unit and the searching deck.

The scanning was conducted by technical forestry personnel of the Forest Service, Corps of Engineers, and of the United States Army Bomb Disposal Team. A searching team was composed of two technical men—one searching and one assisting, and one laborer who chopped out any metal located and rolled the logs for searching. At the beginning of each day, the detector operator adjusted the instrument and checked the detector with "sample blocks" containing metal before scanning the logs. The detector was checked periodically to see that it was performing satisfactorily. A second mine detector was available at all times in case a replacement was needed.

It was found that logs of different sizes required searching in a different manner. For maximum efficiency, logs 8 inches in diameter and smaller were searched on two opposite sides; logs 9 inches to 12 inches in diameter on four sides; and logs 19 inches and larger on six sides. The average log was 11 inches in diameter at the small end and contained 50 board feet.

All logs were marked on the end with lumber crayon by the assistant on each quarter- or half-turn to identify those sides of the log which had been searched. Any lack of marks was evidence that the log had not been searched.

The assistant inspected each log to see that all wounds and suspicious bumps or scars were thoroughly checked with the detector and that logs containing metal were properly marked with crayon. He also saw that all sides of each log were searched and that the logs remained stationary as they were being searched. It was also his job to dispose of the chips and the metal removed from the logs so that their presence on the deck would not interfere with log rolling or searching. Suspicious spots were doubly checked by passing the search-head back and forth over each spot two or three times.

The entire log was turned and searched before any metal removal was attempted by the laborer. This avoided delaying the searching procedure. The search-head was held as close as possible to the log without touching it. This was necessary to pick up weak signals due to the size, character, and depth of metal. Searching the sides of logs with the head held vertical was avoided as much as possible since the back of the head picked up metal in shoes, clothing, or on the ground.

After the log had been searched and the locations of the metal marked with crayon, the assistant and the log roller removed the metal. Before chopping into the log, the bark was chopped off and a check of the spot with the detector was made to see if the metal located was surface metal or was imbedded in the log. On several occasions pieces of wire from wire rope, metal filings, and other bits of foreign metal other than military had clung to the bark. A second check of the spot was made with the detector. If the check still indicated a tone signal, the assistant chopped the metal out with an axe, or removed a section of the log with a saw and splitting wedges. A final search was made in order to be certain all metal was removed.

Unless logs contained more than three or four indications of metal, the assistant could remove it and keep up the supply of logs to the sawmill without removing these logs from the deck or giving them later attention. The percentage of logs containing metal was not great enough to warrant removing them from the deck except in a limited number of cases, and was not great enough to limit the reserve log supply or to slow down sawmilling operations.

When the detector was not in use, the search-head was disconnected from the amplifier and the switch in the amplifier case turned off. Often the detector developed "birdies" in the earphones which could usually be traced to the amplifier. Most of the major troubles encountered were remedied either by installing new tubes or batteries. It was often necessary to interchange parts from one detector to another to locate immediate troubles.

The two detector operators changed jobs at least every hour. This was because continuous operation of the detector longer than one hour by one man tended to build up nervous strain which resulted in searching errors.

It was known prior to the test that the SCR-625 mine detectors were weak in detecting lead and a type of small bullet containing certain alloy metals, and that some of the small bullets would therefore be overlooked by the mine detector. This condition was noted in the case of the 30-calibre bullets containing lead or alloy metal. These bullets could rarely be detected when they were deeper than 4 inches in the log. Further, 30-calibre tracer bullets were difficult to locate because they lacked enough solid metal to make them detectable. When 30-calibre bullets were found they were usually numerous. Deeply imbedded bullets were often missed because the tone in the head phones was faint or lacking. Shell fragments and 50-calibre bullets with steel centers, which are the most damaging to saws and machinery, were located regardless of their depth in the log. The tone heard in the detector head phones was usually clear and distinct. Fifty-calibre bullets which did not have steel centers gave a less distinct tone but the volume of metal in each bullet made them detectable. Because of the intensity of the tone signal, the depth of penetration into the wood did not materially effect the locating of this type metal in these size logs.

In most cases, shell fragments and 50-calibre bullets were imbedded 2 inches to 6 inches and 30-calibre bullets 2 inches to 4 inches into the wood. Most of the metal was within 6 inches of the outside of the logs.

Results

Although the searching of standing trees up to a height of 12 feet was thorough for this portion of the tree, it was difficult to keep the

search-head at an even and effective distance from the trees since the SCR-625 was designed for horizontal searching. In addition, it was difficult to determine which trees remained to be searched, and it soon became apparent that a significant volume of metal had penetrated the trees above the reach of the detector operator.

In the woods, an attempt was made to fell trees which were to be scanned as full-length units so that their butts rested on their stumps. This method of cutting was developed so that the operator could search all sides of the piece. When trees lay on the ground the searching of the bottom side was impossible. When trees were felled in areas where there was heavy hardwood reproduction, it was exceedingly difficult for the searcher to maneuver. Metal detector lines from search-head to coil box caught in brush and limbs and made for difficult and incomplete searching of the trees. Searching was also made difficult on the under side of the tree where branches had been left untrimmed and where brush had been pushed down by the tree. It was found that after metal had been located and the position of the metal marked on the bark with lumber crayon, it was difficult for the person chopping it out to do so because of the brush and location of the metal in the log to the angle of chopping. The greatest disadvantage was the confusion caused by military metal on and imbedded in the ground. Since both sides of the search-head are sensitive, metal on the ground, in back of or in front of the head was detected. Hidden shell fragments in the ground would frequently be spotted by the detector all the way through the log which was itself free of metal. These two preliminary tests indicated that searching of standing and felled trees in the woods was not fully effective and if the system was used it would have to be supplemented by further searching at the sawmill.

The searching of tree lengths and logs at the truck loading point was rather difficult because first, tree lengths were difficult to roll and search, and therefore to chop out the metal; and second, the searcher was interrupted constantly by noise from tractors bringing in logs, from motors on the winch and from trucks backing in and out to load. Tree lengths were often crossed when dropped by the skidder, making searching of the pieces difficult. As was previously discovered, it was difficult to search the under sides of the pieces, and the occurrence of ground metal confused and interrupted the search. Coordination between the searching crew and the bucking and loading crew was difficult since logs which had not been searched would often be pulled onto the loading pile. This system of searching was further complicated by the inconvenience of chopping out the metal. Tree lengths or logs could not be laid aside for further examination or for metal removal. It was concluded that searching at the woods landing stations would not be adequate and that secondary searching would be required under this plan.

Table 1 summarizes the results of searching logs on the ramp at the sawmill. As expected, the presence of metal was different for each area ranging from 1 percent contamination in Strip B to 12 percent in Strip A. The four strips averaged 6 percent. Thirty-one pieces of metal were missed by the searchers on the ramp in the 104.7 M bd. ft. of test logs. The pieces missed were counted as the sawyer encountered them in sawing the logs that had just been searched. All of these were of the 30-calibre type. The thirty-one pieces recorded were only those which were found as they were cut by the head saw. More of this type were missed not only by the detector operator but in the sawing, and remained in the interior of the lumber. Many of these pieces were encountered later in surfacing the lumber at the planer. The board footage in logs and parts of logs lost in chopping out the metal amounted to 1,994 bd. ft. out of a total of 104.7 M bd. ft.

The damage to sawmill equipment as a result of the presence of the 30-calibre bullets was negligible. Sawmilling operations were not substantially delayed either by the sawing of the logs containing the bullets or by the searching operations. Saws were examined at the regular filing periods. Some of the teeth edges had been "rounded" and needed to be pointed up. No teeth were thrown out of the head saw as a result of striking the 30-calibre bullets. No substantial increase in the time or cost for filing of saw teeth was noted.

The lumber cut from the test logs was air dried on the concentration yard, surfaced and shipped. After drying and prior to surfacing and shipping, all of the 1-inch and 2-inch lumber was searched. The detector operator searched the lumber from the tops of the piles. It was found that although some of the 30-calibre bullets were located and removed, lumber containing this type bullet passed through the planer. Planer knives were examined periodically. No damage was noted which could not be remedied in routine filing. The large number of bullets located

TABLE 1.—SUMMARY OF LOG AND VOLUME DATA, PERCENT OF LOGS CONTAINING METAL, NUMBER OF PIECES OF METAL LOCATED AND MISSED BY THE DETECTOR OPERATORS, AND VOLUME LOST IN REMOVING THE METAL

	Strip A	Strip B	Strip C	Strip D	Total or average
Number of logs cut	327	453	388	482	1,650
Number of logs per M bd. ft.	—	—	—	—	23
Av. d.i.b. logs cut (inches)	—	—	—	—	11
Volume of logs M bd. ft. (Int. ¼")	19.8	25.3	30.9	28.7	104.7
Percent of logs containing military metal	12	1	2	11	6
Pieces of military metal removed	5	5	9	187	246
Pieces of military metal missed[1]	22	0	0	9	31
Volume lost in removing metal (bd. ft.)	181	31	50	1,732	1,994

[1]All pieces were 30-calibre bullets. Pieces were those counted at the headsaw as they were sawn.

TABLE 2.—ESTIMATE OF COSTS OF SEARCHING AND REMOVING METAL FROM LOGS AT TWO ADJACENT SAWMILLS, COST OF STUMPAGE LOST AND COST OF LOGGING AND HAULING STUMPAGE LOST IN SEARCHING OPERATIONS WITH CREW SEARCHING 16,000 BD. FT. INTERNATIONAL ¼" RULE PER DAY (EXCLUSIVE OF MINE DETECTOR AND REPAIR COSTS)

Item	Cost per M bd. ft.
	Dollars
Two detector operators @ $1.25 per hour	1.25
One log-roller-chopper @ $0.75 per hour	.37
Tools: bow saw, wedges, axes, cant hooks, saw sharpening equipment, and crayon	.04
Searching stations, ramp, baffle board, and instrument sheds[1]	.25
Logging and hauling costs and stumpage value of board footage hauled to mill and lost due to presence of metal	.44
Total	$2.35

[1]Cost is spread over volume to be cut on entire 600 acres to be harvested since most of the construction could be re-used on other mill sets.

during this process was not recorded.

Two detector operators and log roller-assistant could search and remove the metal from about 16 000 bd. ft. of logs per day if the conditions were similar to those described in this study. Thus it would be possible for a crew of two detector operators and log roller to search and to remove metal from enough material to keep two adjacent portable mills operating steadily.

The estimated cost of searching logs on the ramp on this test with wages computed at a fair commercial rate and considering that the crew could search logs at the two adjacent mills each producing 8,000 bd. ft. per day, amounts to $2.35 per M bd. ft. (See Table 2). These costs included the labor of logging and hauling material which was later discarded in searching. It also includes the value of the stumpage lost in the operation.

Summary

Bullets and shell fragments of different types are occasionally found in timber stands on military installations. In one area of timber known to contain metal, a study was made to determine the amount of contamination and the cost and practicability of locating and removing the metal. Army mine detectors were used for searching approximately 100 M bd. ft. of logs at the sawmill prior to sawing. Only a small percentage of the logs were hardwood. Searching was done by professional men, all of whom had operated mine detectors prior to the test.

Logs were cut from four strips through the largest boundaries of timber and searched at a portable sawmill deck. The percentage of logs containing metal ranged from 0 to 12 percent and averaged 6 percent contamination on all four strips.

Thirty-calibre bullets were difficult to locate with Army mine detectors. A number of this type went undetected. However, it was found that with careful searching, all the damaging metal, which includes shell fragments and 50-calibre bullets could be located and removed economically and without material damage to sawmill or planer equipment providing trained detector operators searched logs and providing proper facilities for searching were made available. There was no material damage to sawmill and planer equipment by the undetected 30-calibre bullets which went into the machines.

It was estimated that a three-man searching team similar to that used in the test could search and remove metal from approximately 16 M bd. ft. of logs per day. The estimated cost of searching this volume at two adjacent sawmills was $2.35 per M bd. ft.

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Methyl Bromide Fumigation of an Illinois Nursery Soil

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RECENT DEVELOPMENTS in the application and use of methyl bromide have made fumigation with this chemical an economical means of controlling obnoxious organisms in forest nursery soils. J. C. Kopitke (*4*) used methyl bromide experimentally at Elsberry, Missouri, in 1949, to control weeds, and in 1950 L. H. Kahler used it at the Union State Tree Nursery, Jonesboro, Illinois, for the same purpose. Clifford (*1*) has reported its use for controlling white grubs and nematodes. It has been used experimentally since 1950 and as standard practice since 1951 at the Mason State Tree Nursery, Topeka, Illinois, to control damping-off of conifers, which in this nursery has been especially serious following green manure crops (*5*).

At the Mason Nursery the effectiveness of methyl bromide against both damping-off and weeds has resulted in impressive economies, despite average application costs of approximately $620 an acre. By reducing mortality, producing more uniform stands of better density, and controlling weeds and insects, methyl bromide fumigation of sixty-seven percent of the seedbed area reduced direct production costs of all first year conifer seedlings by forty-six percent per thousand, a saving of about $20,500 per year. Due chiefly to greater stand uniformity and density, total annual nursery operation expense per thousand plants was reduced one third, a saving of an estimated $38 000 per year. Labor costs on first year conifer beds were reduced 15 percent; seedling density was increased as much as 168 percent without increased seeding rates; weeds were controlled with a minimum amount of hand weeding and mineral spirit spraying; and soil insects have not been a problem. Growth of northern pine seedlings invariably has been greater on fumigated soil.

The Mason State Tree Nursery is located in central Illinois on a brown sandy loam soil containing twenty-five to fifty percent clay. Standard nursery practices are followed, modified to meet local conditions of soil, labor and environment. Seeding of white pine in the fall and red and jack pine in the spring is aimed at a density of 35 to 40 trees per square foot for seedling production. Some conifer seeding follows other conifers and some follows green manure crops. The usual green manure crop is sudan grass, plowed under with nitrogen in July. Methyl bromide soil fumigation is practiced following green manure crops before pine seedbeds are established.

Methyl bromide is a highly toxic, colorless, odorless, heavy liquid, with a boiling point of 38.6° F., or heavy gas at higher temperatures. Toxic effects on humans are delayed and may not occur for several hours. These properties, and its volatility make it extremely hazardous unless adequate safety precautions are taken. The U. S. Bureau of Mines states that operators should not be exposed to concentrations of 30 parts per million more than one hour per day, or, with suitable gas masks, at concentrations of more than one pound per 1,000 cubic feet. Elkins (*2*), who is an outstanding industrial toxicologist, states that, "In view of the severity of methyl bromide poisoning, I therefore recommend a maximal allowable concentration of 10 ppm for this substance." Gas masks with suitable canisters should always be available for emergencies, for use in buildings and depression, when leaks occur, and in removing covers on windless days when concentrations of gas may occur. The area should be posted and children and animals kept out of the area. Gloves should not be worn and clothing should be removed immediately if methyl bromide is spilled on it, since vesicular dermatitis and second-degree burns may result from prolonged contact. Normal precautions include working on the windward side, if possible; allowing thirty minutes for the gas to dissipate after removal of covers; remaining away from any area where gas is detected; being alert and careful at all times; and following the manufacturer's instructions explicity. No injury resulting from methyl bromide has been observed at the Mason Nursery.

Fumigation Procedure

The essential steps in fumigation are preparation of the soil; placement of the apparatus on the beds; the injection of the fumigant under the gas-tight covers; and the removal of the covers. Since the soil temperature must be at least 50° F. to be effective, fumigation at the Mason Nursery is done in the fall after the green manure has partially decomposed, and is completed by mid-October before soil temperatures and weather become unfavorable. Pairs of beds are fumigated progressively from south to north, to take advantage of the prevailing southwest winds.

The equipment and supplies used at the Mason Nursery consist of:

1. Gas masks for use, if needed;
2. Gas-tight covers of polyethylene, 13½ by 100 feet, .004 inches thick, weight 27 pounds;
3. Plastic cement for fastening the ends of the covers together to make a continuous cover the entire length of the area;
4. Waterproof cloth tape, 1½ inches wide, is also used in fastening the ends of the covers together, and for repairing holes in the covers;
5. One gallon rectangular cans, with rigid handles;
6. Saran tubing, ¼ inch outside diameter in 15 foot lengths, to be inserted in the cans and taped to the handles;
7. Stout cord in 15 foot lengths to be tied to the handles of the cans;
8. Two dispensers (3 pound ca-

TABLE 1.—AVERAGE ANNUAL PER ACRE PERSONNEL COST OF SOIL FUMIGATION, 1951-1954

	MH/A	Cost/A
Soil preparation, including ridging and tilling	9.07	
Preparation of cans, tubing, and taping and initial placing of covers	19.34	
Turning and moving covers	77.43	
Application of the fumigant	16.92	
Removing and storing covers after fumigation is completed	7.63	
Receiving and storing fumigant	.79	
Repairing covers for future use	26.12	
Total labor	157.3	
Rate/hour	$ .932	
Total labor cost		$146.61
Supervision, including some application of fumigant and checking of covers	5.37	
Rate/hour	$1.51	
Supervision cost*		$ 8.11
Total personnel cost		$154.72

*Additional time required for procurement, planning, and development work is not included.

TABLE 2.—FUMIGATION DATA SUMMARY ON A PER ACRE BASIS

Year	1951	1952	1953	1954	Weighted Average
Acres fumigated	5.60	7.92	5.12	10.40	7.26
Rate/100 sq. ft.	1.72	1.34	2.11	1.85	1.74
Man hours/A	145.6	137.6	254.7	145.72	162.67
Personnel cost/A	$130.85	$127.44	$245.71	$141.28	$154.72
Fumigant cost/A	$449.60	$327.59	$460.14	$404.37	$401.97
Equipment & supplies/A	$119.62	$ 81.84	$ 64.54	$ 16.12	$ 62.53
Total cost/A	$700.07	$536.87	$770.39	$566.02	$619.22

pacity), attachable to the cylinders of fumigant, and equipped with neoprene rubber tubing, for measuring and transferring the fumigant to each receptacle through the saran tube;

9. Masking tape for sealing the ends of the saran tubes, which protrude from the edge of the cover;

10. Methyl bromide soil fumigant in 150 pound pressure cylinders, which are transported during fumigation in a transport box on the back of a Ford tractor;

11. Sixteen foot 2 x 4's of smooth lumber.

The first step in fumigation is ridging all of the beds with a disc ridger. A four-foot rotary tiller is then used to pulverize the two southernmost ridged beds as deeply as possible just before fumigation. The cans are placed at 24-foot intervals on the edge of one of the beds near the furrow between them. The tubing is extended to the north side, where the fumigant will be applied. The cord is extended to the south side, opposite the beds to be fumigated later. The cover is placed over the pair of beds and the cans, with the tubing and cord projecting, and the edges of the cover are sealed down with soil. The cover is examined carefully and all holes are patched before the fumigant is injected.

A central support under the cover has been eliminated at the Mason Nursery because the furrow between the beds, close spacing of the receptacles, gaseous diffusion, wind action, and support afforded by the cans apparently permit free gas circulation. The covers are usually weighted with 2 x 4 lumber to reduce billowing. On sloping ground, heavier applications should be made at the top of the slope, and the furrow between the beds should be blocked at intervals to prevent excessive downward movement of the heavy fumigant.

The liquid fumigant, which boils at 38.6 degrees, is under pressure in the original container. As soon as the cylinder valve is opened to the dispenser, which is graduated in pounds, the liquid flows into the dispenser until the valve is closed. Pressure immediately builds up in the dispenser forcing the liquid into the tubing when the dispenser valve is opened. The dispenser tubing is connected to the saran tubing allowing the fumigant to pass into the receptacle under the cover. After the transfer is completed through each saran tube the dispenser valve is closed, the applicator tubing disconnected and the end of the saran tubing covered with tape.

The cover is left in place for at least 24 hours, after which the south edge of the cover is loosened to allow the cans to be pulled from under the cover by means of the attached cords and placed on the next pair of beds to the north, which have been freshly tilled for fumigation. The free edge of the cover is pulled from the south side of the fumigated to the north side of the unfumigated pair of beds, and sealed down. In this manner all soil in an area is subject to fumigation, since the soil used in sealing the cover is turned under each time the cover is moved.

Twelve covers averaging 280 feet in length, covering .92 acres were used to fumigate 10.4 acres in 1954.

The average area fumigated between September 9th and 23rd was .48 acres per day, with a maximum of .79 acres in one day. Some fumigation was performed each working day, since only two rains of .1 inch each occurred. Bad weather, placing, repairing and moving covers, placing the fumigant, aeration and unavoidable delays prolong the fumigation period beyond the minimum fumigation time of 24 hours.

Recommended dosages per 100 square feet are one pound for weeds and two to four pounds for damping-off. At the Mason Nursery rates of from 1.34 to 2.11 have been satisfactory to excellent. An average application of 1.5 pounds per hundred square feet is recommended under favorable conditions where damping-off fungi are involved. Soil, weather, and efficiency influence results and presumably the optimum amount of fumigant to apply.

Cost Data

Costs of seedbed fumigation have been kept over a four-year period from 1951 through 1954. The average annual per acre costs for labor and supervision are presented in Table 1.

TABLE 3.—COMPARISON OF AVERAGE ANNUAL PRODUCTION DATA PER SQUARE FOOT FOR TWO YEARS BEFORE AND AFTER FUMIGATION WAS PRACTICED

	Spring seedbeds			Fall seedbeds			All seedbeds		
	Unfumigated	Fumigated	Percent Improved	Unfumigated	Fumigated	Percent Improved	Unfumigated	Fumigated	Percent Improved
Percent fumigated		49.5			78.9			56.7	
Total labor cost	.176	.166	5.7	.452	.215	52.4	.210	.178	15.2
Other direct costs	.051	.036	29.4	.058	.022	65.5	.058	.033	43.1
Combined labor & direct costs*	.227	.202	11.0	.510	.237	53.5	.268	.211	21.3
Seedling density	31.6	38.7	22.5	13.1	35.1	168.1	26.0	39.3	51.1

*Items such as mineral spirits, which are used on all classes of stock are not included, since the amounts used on 1-0 stock are not readily available.

Average annual per acre data and the weighted per acre averages for the four-year period appear in Table 2. Labor costs were high in 1953, due to an unusual amount of repair work on covers in relation to the relatively small acreage fumigated. Labor costs rose from 85¢ per hour to 97¢; fumigant costs were reduced from 60¢ to 49¢ per pound by the use of cylinders instead of one pound cans; and annual expenditures for equipment and supplies decreased from $119.62 to $16.12, due to repeated use, and averaged $62.53 for the four year period.

Comparison of Results

A general idea of the results of fumigation at the Mason Nursery may be obtained from Table 3, which compares average annual data for the first two years of fumigation with the two preceding years.

The 2 percent inventory of 2-0 red pine seedlings in 1953 reveals that 8,800 feet of fumigated seedbed produced 49.4 red pine 2-0 per square foot, while 21,376 feet of unfumigated seedbed produced 27.2 per square foot with the same seeding rate. 81.5 percent more seedlings were produced with fumigation following a green manure crop than with unfumigated soil which had no green manure crop.

Small check plots in fumigated areas each year have invariably confirmed the effectiveness of the treatment.

Discussion

1. Due to heavy damping-off losses following green manure crops, red and white pine seedlings could never be grown in uniform stands of proper density under Mason State Tree Nursery conditions. An alkaline water supply probably contributed to the development of the fungi. Acidification of the water, soil treatment with iron sulphate before and after germination, mulching, shading, changing and removal of the green manure crop, and fall seeding of white pine gave varying degrees of control, but were all inadequate.

2. The use of green manure crops is considered good practice, although it is very expensive in terms of damping-off losses and control. Peat at $5 per yard is also a costly source of organic matter. Heavy sawdust and ground corncob mulches applied as a winter mulch for frost heaving and incorporated with the soil one or two years later add some badly needed organic matter to the soil.

3. Soil fumigation with methyl bromide eliminates damping-off losses, is more effective than mineral spirits for the control of many weeds and grasses, and may control soil insects and other harmful organisms at the Mason Nursery.

4. Mortality of beneficial soil organisms has not been a noticeable problem with northern pines, black locust and cottonwood under Mason Nursery conditions. Kopitke (*4*) makes the following observation: "While this type of treatment destroys all or part of the soil organisms in the horizon within a few inches of the soil surface, competent soil scientists and pathologists indicate that this effect is temporary, the soil being quickly reinoculated with new organisms carried by wind and rain or by somewhat more gradual inoculation from organisms which persist below the affected soil layer."

5. Methyl bromide fumigant may be used safely in nursery operations if the manufacturer's instructions are followed explicitly with good judgment and caution.

6. Seeding rates at the Mason Nursery have been reduced 50 percent with good seed, and the increased tree percent with weak seed of low germinative energy is even more impressive. Uniform stands of proper density throughout result from proper seeding and culture when damping-off, one of the greatest variables, is eliminated.

7. Growth of northern pine seedlings has been more rapid on fumigated soil. Fumigation may depress the growth of plants requiring nitrate nitrogen, due to the mortality of nitrifying soil organisms, but this does not appear to be a problem on Mason Nursery soil with the species named. Nitrogen applications are necessary during the second and third growing seasons, presumably because of the decomposition of the winter mulch, which is not removed.

8. The capacity of the nursery has been substantially increased through fumigation. The stock produced is more uniform, and the quality is being controlled more completely by the elimination of harmful soil organisms.

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Empirical Volume Tables

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ACCORDING to Spurr[1] the first modern volume table was published about 1804. Since then hundreds of other volume tables have been prepared by established procedures such as harmonized curves, alinement charts and use of form class. Each of these methods requires detailed measurements of individual trees and considerable office work. The end of such toil is not in sight due to constantly changing standards of utilization which alter the volume table requirements of foresters. The purpose of this paper is to report on a new method of volume table construction which permits the use of large numbers of trees at much less cost than conventional methods and without loss in accuracy.

Schumacher and Jones[2] demonstrated that an empirical log rule can be deduced from observational data for which the sampling unit was the working day at the sawmill rather than the individual log as in the conventional method. This does not interfere with production at the sawmill and reduces to one the number of people required to obtain the necessary information. Schumacher and Young[3] later extended this technique to the development of graded log rules.

While visiting the completely mechanized hardwood logging operation of the S. D. Warren Company in the vicinity of Bingham, Maine, it occurred to the writer that the method of Schumacher and Jones referred to above might well apply to the construction of volume tables. On this particular operation tree length logs are hauled to a cut off saw at a centrally located yard. Inasmuch as the company employs a bonus incentive based on the daily production in cords those records are available.

Since the average stump height is about one foot, the approximate d.b.h. can be measured 3.5 feet up from the butt end of each tree length log and the number of four-foot bolts in each tree length log could easily be counted at the cut off saw where the upper limit of merchantability is four inches whenever practical.

From these measurements a model equation was prepared; that is

$$V = b_o + b_1 D^2 + b_2 B + b_3 D^2B$$

where

V is the cord volume of an individual tree,

D the diameter at breast height, and B the number of merchantable four-foot bolts.

Then with the entire day as the sampling unit of n tree stems, the equation becomes

$$\underset{S}{n(V)} = b_o \underset{S}{(n)} + b_1 \underset{S}{n\,(D^2)} + b_2 \underset{S}{n\,(B)} + b_3 \underset{S}{n\,(D^2B)}$$

This can be summed up for k days as

$$\underset{SS}{kn(V)} = b_o \underset{S}{k(n)} + b_1 \underset{SS}{kn(D^2)} + b_2 \underset{SS}{kn(B)} + b_3 \underset{SS}{kn\,(D^2B)}$$

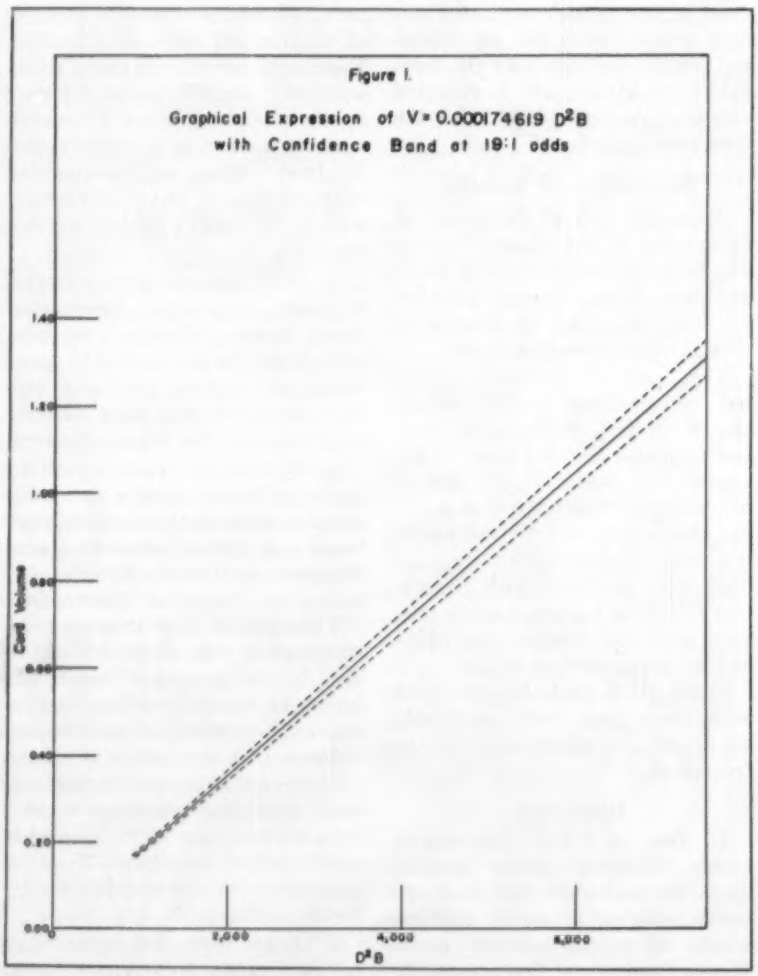

FIG. 1.—Graphical expression of $V = 0.000174619\ D^2B$ with confidence band at 19.1 odds.

[1]Spurr, Stephen H. 1952. Forest Inventory, Ronald Press, New York. 476 pp.

[2]Schumacher, F. X. and W. C. Jones, Jr. 1940. Empirical log rules and the allocation of sawing time to log size. Jour. Forestry 38:889-896.

[3]Schumacher, F. X. and H. E. Young. 1943. Empirical log rules according to species groups and lumber grade. Jour. Forestry 41:511-518.

where the weight for each day is

$$\frac{n}{[n(D^2B)]^2 \over S}$$

The S. D. Warren Company cooperated in this study by having one of its scalers record the d.b.h. and number of merchantable bolts for each tree length log and the daily production in cords for each of 21 days scattered over a period of several months.

In the analysis of variance the only significant variable was D^2B and it did account for a large portion of the sums of squares. The final equation then was

$$V = 0.000174619D^2B$$

This is graphically depicted in Figure 1 with the confidence band at odds of 19:1. It would be advisable to begin any similar studies with a model equation similar to the one above. This should be done because differences in tree form due to species and site might require more than one variable to obtain a satisfactory equation.

The field and office work for this study involving 3,090 trees took about 25 working days. Conventional techniques would have required five to eight times as long. This striking difference would be reduced somewhat if data were collected over a wide region.

In the northeast, the majority of pulpwood operations are either the "stump wood" or "yarded wood" type. It seems reasonable to believe that this empirical method could be extended to such operations and to tables for individual species as well. On such operations the sampling unit, for purposes of volume table construction, would have to be individual piles of stacked wood rather than the day. This undoubtedly would increase field costs over the technique employed on a completely mechanized operation, but the increase in office work would be small.

The cord is the unit of pulpwood measurement in the northeast and its variable solid contents is an item of major concern. Piling methods probably contribute more to this variation than any other single factor. Therefore the differences between estimate of standing timber using this equation and the actual measurement of piled pulpwood cut from that standing timber might well be attributable in part to such factors as piling which are not easy to evaluate. Experienced men did as good a job of piling as could be expected on the pulpwood piles used in this study. Caution with regard to piling techniques should be exercised on any similar studies.

Summary

The empirical method of log rule construction developed by Schumacher and Jones has been extended to volume table construction. An empirical equation appropriate to a completely mechanized hardwood logging operation was developed with a very narrow confidence band at odds of 19:1.

This method of volume table construction reduces both field and office work considerably and warrants consideration on conventional pulpwood operations where new volume tables are needed for individual species or species groups.

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Tennessee's Timber Economy

Timber and timber products contribute $190 million to Tennessee's income and 30,000 man-years of employment annually, according to a report issued by the U. S. Department of Agriculture and based on a survey of the state's forest resources and industries made by the Southern Forest Experiment Station. The Tennessee Division of Forestry and the Tennessee Valley Authority assisted in the survey.

The value of round timber products cut for domestic use and sale in the state was estimated at $54 million for 1950, the latest year for which such figures are available. Further manufacture of timber products within the state add $136 million in value.

The prospects for even greater forest income are encouraging. New or expanded markets are developing for pine pulpwood, hardwood pulpwood, pine fence posts, and chipped sawmill residues.

According to the report, many landowners and timber operators are taking more interest in managing their forests scientifically. Most of Tennessee's timberlands are without management or are in an early state of transition from unmanaged to managed forests. Increasing annual timber growth to meet the long-range needs of the state's growing population and expanding industrial economy will require more adequate protection of forest lands against fire, insects, and disease; cutting or killing worthless cull trees; improved harvesting practices; and reforestation of idle, eroding abandoned farm lands.

Copies of Forest Resource Report No. 9 are available at the State Forester's office, Cordell Hull Building, Nashville, Tenn., or at the Southern Forest Experiment Station, 2026 St. Charles Avenue, New Orleans 13, La.

Forest Growth Goals in a Private Enterprise Economy

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A PRECEDING ARTICLE was devoted to a critical analysis of the framework within which the Forest Service has established growth goals, or production goals, for American forestry.[1] Two major shortcomings of that framework were disclosed: costs of production (the supply factors) had been ignored, and the time inter-relationships of stumpage production had not been systematically considered (the approach was static). As a result of the analysis, it was suggested that forest growth goals be re-defined—that they represent planned patterns of stumpage output over time instead of output targets for some arbitrarily chosen date.

Growth goals of the proposed type would serve as logical guides to major forest policy decisions. For this reason, if for no other, it seems highly desirable to build a valid framework for their formulation. This is the first objective of the present article—to sketch the essential features of a suggested methodology for growth goal determination. A second objective is to examine by discussion the basic features of the method.

Why growth goals?—Prior to presentation of the method itself it seems desirable to explore briefly a question basic to production goals of any type. This question is simply, "Why develop goals? What are they good for?"

The past provides some help. Previous growth goals have been used as a foundation for proposed action programs. For example, the last analysis called for an annual production of 18 to 20 billion cubic feet, including 65 to 72 billion board feet of saw timber.[2] The action program proposed to facilitate attainment of this goal was embodied in three major categories of recommendations: (1) Public aids to private forest land owners, (2) "Public control of cutting and other forest practices on private lands sufficient to stop forest destruction and keep the land reasonably productive," and (3) Expansion, and intensified management, of national, state, and community forests.[3]

Details of the action program are, of themselves, unimportant to a discussion of growth goals. What is important is the fact that the goal was the "springboard"—the "raison d'etre"—for the entire action program. The question, How can growth goals be used? might be countered by another question: How can one decide on action programs in forestry *unless* one knows approximately how much wood the nation's forests should be growing?

Yet this is at best a partial answer, for with a specific growth goal of x billion cubic feet one might still ask, Why a goal of x billion? Why not half—or twice—this much?

The complete answer cannot be found in growth goals per se. Production goals of any kind are useful because they establish a physical output that must be attained if other objectives are to be met. Production goals are secondary goals; they are derived from some more basic objective. For example: with profit maximization as an ultimate objective the entrepreneur can derive an *output schedule*— a production goal—which will permit (though perhaps not assure) maximum profits to be achieved. Production goals are working objectives rather than ultimate aims. They are performance guides—intermediate goals that must be achieved in order that basic objectives might be attained.

Goals can be set without reference to either production technoeconomic realities of the world. Such goals, however, can seldom be rational guides to production. Moreover, they can be downright dangerous if made the basis for policy decisions: their attainment may require major and undesirable changes in our social or economic way of life. Obtaining general approval of such goals may be a prelude to gaining acceptance of previously disputed policy, for once the goal is accepted logic may force acceptance of the methods proposed for its achievement. It is, in fact, entirely possible for goals to be *formed as a result of* established policy instead of being used as *guides to* policy establishment.

This article is not concerned with goals springing *from* policy decisions. It is concerned solely with the derivation of production goals which may serve as logical guides to policy formulation. A prerequisite for such goals is a rational, logical method for their derivation.

The time-jointness approach.—The approach to be developed is based on the economic theory of joint production and has been called the "time-jointness" methodology. Its essential features are relatively simple; actual derivation of specific quantitative goals may be more difficult.

The principal advantage of the time-jointness method stems from the fact that its use permits specific recognition of time interdependencies. A definite *period* of analysis is selected and divided into a number of *intervals*. A *period* of 50 years, for example, might be divided into five ten-year *intervals*. The output of each interval would then be viewed as a separate product, and the central problem becomes one of discovering the particular combination of products that would permit attainment of the ultimate objective, whatever this latter might be.

The steps through which this product combination can be determined may be summarized as follows:

1. A set of interelated supply functions (equations or curves) is determined. If five intervals had

[1] Gregory, G. R. An analysis of forest production goal methodology. Jour. Forestry 53: 247-252. 1955.

[2] U. S. Forest Service. Forests and national prosperity. U. S. Dept. Agric. Misc. Pub. No. 688. p. 3. 1948.

[3] Ibid., p. 6.

been decided upon, there would be a set of five supply functions—one for each interval. In forestry, these would necessarily be related because of the time interdependencies involved in stumpage production.

2. A set of functions (equations or curves) describing the demand for the product is determined. Again there would be a demand function for each interval, or (using the same example of 5 intervals) five functions in all. These may also be related through time.

3. The final step is simply the simultaneous solution of the two sets of functions. This gives the set of equilibrium outputs—a pattern of output over the entire period which is determined, essentially, by the intersection of the supply and demand curves.

The specific result achieved by application of this series of steps will, of course, depend upon the working assumptions with which one begins, and the objective toward which the growth goal is oriented. The presentation which follows is predicated upon three basic assumptions which should be held in mind throughout the development; discussion of their applicability follows the sketch of the model. The key assumption is that forest production will be carried on in this country with the primary objective of making a profit. The second assumption is that the stumpage-producing portion of the forest economy can be characterized as operating under essentially purely competitive conditions. The third assumption is that the area of land to be devoted to the production of forest products will remain approximately constant.

With these three assumptions as a starting point, the problem of growth goal formulation can be restated as one of determining the particular pattern of stumpage output through time that will maximize the present net worth of the nation's forest land. We thus rule out, for the time being at least, problems raised by the many nontimber values associated with forest land.

The growth goal problem, and the basic ideas of the time-jointness approach, are developed in Figures 1 and 2. Figure 1 presents the usual static approach to supply and demand integration for any particular instant of time.

Supply is represented by a curve showing the quantities of the product that producers will place on the market at various prices. Increased quantities can be furnished only at increased prices: increased stumpage production requires an increase in the "inputs" of management—man hours of thinning, pruning, fire protection, weeding, insect control, under-planting, etc.

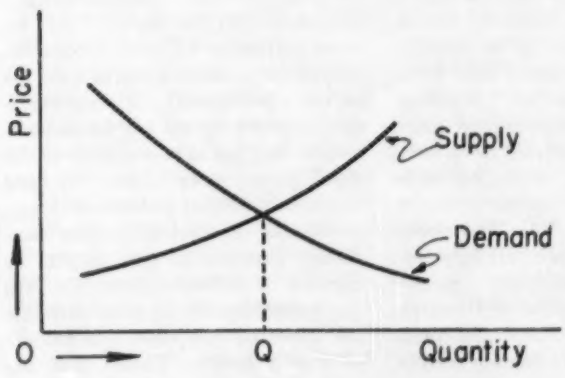
Demand is similarly represented, though here the curve is based on consumer psychology and plain common sense. The demand curve shows that, other things being equal, people will buy more of the product at lower prices than they will at higher prices. This relationship holds true whether the goods happen to be one that is consumed directly, such as bread, or one that is used to produce other goods, such as steel or wood.

The particular quantity, Q, which will satisfy both of these curves is determined in the market, for producers will produce no more than they can sell at a profit, while consumers will take only a certain quantity at any one price.

But the physical supply of stumpage can be changed only over fairly long time intervals. It takes time to realize the benefits of increased intensity of management. Furthermore, *future* stumpage production is dependent on *present* growing stock, and therefore on *present* harvest. The supply curves of different time periods are not independent. They are inter-related due to the basic *time interdependencies* of the production process. The simple, static model of Figure 1 is not applicable to forest growth goal determination.

Figure 2 represents an attempt to illustrate the kind of model we need. The quantities Q_1 and Q_2—the growth goal, or pattern of stumpage output over time—are again determined by the intersections of demand and supply curves.

But the two supply curves are not independent: a change in one will have an effect upon the position of the second. The connection illustrated is direct and simple; a decrease in the quantity offered now means more to be offered in the future. And in general this would be correct; less harvest in the present means an increase in growing stock which, in turn, makes possible greater production in future intervals. But any forester could cite conditions under which this might not be true. There



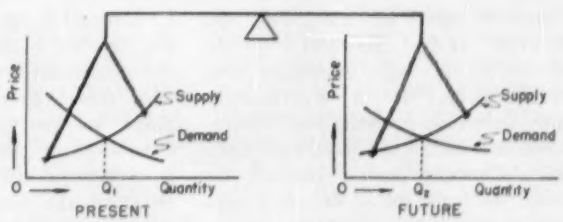


FIG. 1.—(*Left*) The usual static approach to supply and demand integration. Time interdependencies of supply cannot be demonstrated in this model.

FIG. 2.—(*Above*) An overly-simple graphic model for growth goal determination. The supply curve of the present is "tied" to the supply curve of the future.

should be a series of springs and pulleys in the connecting mechanism so that while a shift in one would usually be reflected in the other, off-setting reactions would also be possible. Furthermore, some mechanism making it possible to change the *shape* of the curves should also be provided.

It appears that a simple, diagrammatic model cannot serve for logical growth goal formulation. An alternative is to derive mathematical functions to replace the geometric curves, thereby permitting an approximate portrayal of the relationships among several variables. The growth goal model requires a series of interelated supply functions, and perhaps a series of inter-related demand functions as well, for demand may also be connected over time. Solved simultaneously, these two sets of functions will give us the required growth goal.

The supply side.—The logic underlying derivation of the required supply functions proceeds directly from the first two assumptions. Each producer in a purely competitive industry, when acting so as to maximize profit, will adjust his production volume until any further alteration in output will change his costs just as much as his revenue. Therefore, if he remains in business and acts so as to maximize profit, the producer will always be guided by changes in production cost—by his *marginal cost curve*. And because of this, the firm's marginal cost curve is also its supply curve, for this function will show how the firm will react to changes in product price.

Admittedly, one could hardly hope to construct marginal cost curves (or individual supply curves) for every stumpage producer in this nation. Fortunately for national growth goal determination we do not need each *individual* supply curve. Instead, we must derive a set of *industry supply curves*. These latter may be regarded as marginal cost curves for the nation's stumpage factory —the curves or functions that show how total production costs will change as we change the output of the various time intervals. To derive these functions requires that we go back to the physical basis of forestry and ask how, from the given area of forest land, the output for the different time intervals might be changed.

One way, of course, is to change the level of forest management—to change the inputs in one or all of the intervals being considered. The production of any product, whether it be corn, automobiles, washing machines—or stumpage—requires that certain materials or inputs be combined in particular ways. And this is true whether man plays a part in the production process or not. Man had little to do with the combination of variables that made possible the vast pine forests of the Lake States, though he played an important role in the establishment of the extensive aspen stands that now cover much of the same area. Yet the very existence of these stands is proof that certain biotic variables did react in a particular way.

The growth goal model, then, requires a knowledge of the relationship between inputs and outputs of the different time intervals. But it requires more than this, for (as we have previously seen) the planned output of any one interval may also be changed by changing the harvest of other intervals. The physical data required for growth goal formulation, therefore, include information on "output-output" relationships as well as on "input-output" relationships.

While this means that the task of obtaining and organizing the physical data may be somewhat complex, it scarcely implies that it is impossible. As scientific foresters, we are beginning to identify the important variables that influence forest production. Furthermore, we are beginning to learn how some of these can be altered in either quantity or timing so as to affect the final forest product, standing timber. This knowledge is the physical basis of all forestry; silviculture is concerned entirely with the identification of these variables and with their manipulation so as to achieve certain results.

These physical relationships are fundamentally important, but in an economy such as ours they are not the sole determinants of production methodology. While it is physically possible to grow bananas in Detroit, one nevertheless cannot buy Detroit-grown bananas in the corner grocery. In a profit-oriented economy physical data must always be combined with economic information to determine practical methods.

The economic data needed to complete the supply side of the picture are those concerning costs of the various physical inputs. And, since timing as well as quantity and price of inputs is important, some method is required to make the values of inputs at different intervals directly comparable. By using the familiar technique of discounting to a single point in time (the present will usually be chosen) this aspect of the time problem is readily managed. Then, knowing the physical relationships between input and output, and having the discounted costs of the inputs, we can construct a function showing the total cost of producing stumpage over the entire period *in terms of the outputs of the different intervals.*

From this total cost equation can be derived the marginal cost functions for the production of stumpage during each intervals. These latter expressions make up the needed set of supply curves—a set of equations specifying the change in cost as a function of the outputs of the different intervals.

To summarize the supply side of the growth goal model: both physical and economic information are necessary. On the physical side we must estimate: (1) the inputs required to produce stumpage on the nation's forest land; (2) how variation in these inputs will cause associated changes in the output or the yield of stumpage; and (3) how changes in output or harvest in any particular interval will cause associated changes in the output or harvest of different intervals. On the economic side we must estimate the expected cost rates (or prices) of these inputs. These data are

combined into a set of inter-related marginal cost functions of forest production. This is our set of inter-related industry supply functions.

The demand side.—During the past decade a great deal of new knowledge has become available in the general area of demand analysis. Economists working with other industries have accomplished much along lines of quantifying demand relations for their particular products. There is little to suggest that quantification would be any more difficult in forestry than in other fields.

The particular problem at hand is the determination of a set of demand functions for forest stumpage—a set of functions quantifying the relationship between the price of stumpage and the quantity purchased. Many factors besides price influence the quantity of stumpage purchased, and the identification of these variables would form a most interesting part of any demand analysis. The number and exact nature of the variables that would appear in these functions can scarcely be known until work has progressed considerably beyond the current stage. We know for certainty, however, that two key factors would be quantity and price for each interval being studied. Whether either quantity or price during one interval is a significant determinant of price and quantity in other intervals is again a matter for conjecture—conceivably they might be. The end result of the demand analysis would be a set of stumpage demand functions in terms of quantity and price. Other significant variables such as national income and population would be determined outside the forest economy.

The integration of supply and demand.—The final step in the time-jointness framework is purely mechanical. Given a set of supply equations in terms of quantity and a set of demand equations in terms of quantity and price, the problem is simply that of finding the set of outputs which simultaneously satisfies the two equation systems. By themselves neither system is determinant but we know that in a purely competitive system profits will be maximized when marginal cost equals price. By substituting the series of marginal cost (or supply) equations for the price variable in the demand functions, thus making marginal cost equal to price, we will be left with a system of equations in which the only unknowns make up the set of quantities to be produced in each period. There will be as many equations as unknowns, and (unless there are some peculiar equation types) the system can be solved simultaneously for a series of specific quantities of stumpage output.

These quantities are very particular quantities, for if all our estimates of values, costs, etc., are correct we will plan to produce in each interval exactly that amount of stumpage that can be sold at a price just high enough to pay for the last one thousand board feet of logs producers are willing to grow. This is the forest growth goal for a free-enterprise economy.

As a summary of the technique the essential steps might be repeated: (1) integration of physical and economic data through a set of inter-related supply curves, (2) determination of a set of (perhaps inter-related) demand curves, and, (3) determining the set of equilibrium outputs. Under our assumption of pure competition in the sale of the product, this is also the set of outputs which will maximize the present net worth of the nation's forest lands.

Discussion of the Methodology

Objectives.—One of the major questions about the proposed method concerns that of objectives: Is profit maximization a suitable objective toward which to orient national growth goal analysis?

The forest economy of the United States has been in the past, and certainly will be in the future, subjected to many influences, not all of which are conducive to private enterprise. Yet it seems clear that if our forest growth goals—regardless of methodology—are to be set realistically, the fact that about 75 percent of our commercial forest land is in private ownership must be recognized. This means that a growth goal for American forestry must at least be compatible with the basic objectives of private ownership.

It is believed that the basic objective of private forestry in the United States has been, and will continue to be, the maximization of profit. This does not mean that every private owner is out to squeeze the last nickel from his forest acres—only that decisions made concerning private forest land are based, by and large, upon the profitability or non-profitability of the action. Facing the alternatives of a profitable or an unprofitable action, the private entrepreneur will choose the first: given the choice between two actions, both of which are profitable, the private entrepreneur will choose the more profitable of the two (other things being equal). And, in so far as we assume continuity of existence, maximization of profits over time is a logical objective of the forest entrepreneur. This can be achieved by maximization of the present net worth of the property.

Private versus public objectives.—Is the *private* objective of profit maximization compatible with policy objectives of a *public* agency concerned with the welfare of the nation as a whole? To answer this, let's start by granting the original assumption—that stumpage production is purely competitive. Then each forest owner, when operating so as to maximize his own profit over time, will plan to produce so that the marginal cost of stumpage production will just equal its selling price. Since price will be at the level of the intersection of the demand and the supply curves, all those who want stumpage will be able to get it if they pay the cost of producing the last required unit: that is, consumers can get as much stumpage as they are willing to pay for, whether this happens to be fifty billion, seventy-two billion, or one hundred fifty billion board feet per year. But if stumpage production is an industry of increasing cost (and there is little reason to suspect otherwise) the more stump-

age consumers get, the higher its price is going to be. This relationship between production, consumption and price is what gives consumers in a competitive economy a "reasonable choice of available materials." With each of their purchasing dollars they cast a vote for the production of the product purchased. The system then totals up these votes and allocates the various resources of the nation—land, labor, capital and management—in such a way that the "voted" amount of each product is produced.

Viewed nationally—which is the way a public agency should look at the picture—stumpage production actually does not depart greatly from purely competitive conditions. There are over four million owners of forest lands in this nation, only one of whom conceivably controls enough forest land at the present time to materially influence stumpage prices. That one is the National Forest Service itself. If this organization were to adopt a marginal cost pricing mechanism for federally-produced stumpage, this output would not only mesh with that of the nation's privately-owned forest land but would also serve as a barrier to possible future monopolistic developments.

Now let's take a look at the alternative—suppose stumpage were *not* produced under purely competitive conditions. Under this assumption the growth goal established by the suggested method would nevertheless be a logical one toward which public policy objectives might be oriented, though owner profit would no longer be maximized. For achievement of the goal so established would assure production of all the stumpage for which consumers could pay. At the same time production of quantities that might depress market prices below production costs would be avoided.

Such a goal might not maximize welfare for many reasons. Perhaps chief among these is the readily observed fact that not all industries approach purely competitive conditions. Furthermore, the model contains nothing whatever about income distribution—a major consideration in questions of welfare. But maximization of welfare is an objective only slightly less ephemeral than "the greatest good for the greatest number in the longest run." A growth goal established under a marginal-cost pricing mechanism will satisfy the needs of consumers as these needs are expressed in the market place, and "consumers" includes almost the entire population.

Problems of estimation.—For the sake of simplicity the model was presented as yielding a single set of outputs over time that would be the final answer to the growth goal problem. Actually nothing quite this neat should be anticipated. One should not expect to estimate future costs, prices, technologies, or populations with such accuracy. It should be possible, however, to establish a reasonable range for these variables, and within this range to arrive at production goals that make sense to public and private foresters alike.

Whenever long-range forecasting is involved in a problem, someone will demur at the possibility of achieving any worth-while solution. But forestry by its nature is a long-term proposition and we are only kidding ourselves if we think we can avoid making forecasts. Every time a plantation is established by a private corporation there is an implicit forecast that future market prices will be at least sufficiently high to cover all planting costs and carrying charges. A major advantage of the proposed system lies in the fact that it forces the planning agent (or agency) to be explicit in his estimates.

Periodic planning.—It might be asked whether a system suited to planning by definite periods is applicable to forestry. As a matter of fact the periodic treatment accorded by the model is a definite advantage, for forestry is by nature a periodic process. Moreover, there is nothing that requires one to be satisfied with a "single stage" approach. Suppose, as an extreme, we plan a 100-year period by 20-year intervals. If more detailed plans are desired, we can use the result of this long-term plan for establishing "boundary conditions," then re-plan the first twenty years—perhaps by four year intervals. This process could be repeated as often as desired; each time more detail could be incorporated, yet each time the detailed plan would be consistent with the long-term plan.

And this is about the way we do make plans. The greater the time span involved, the more opaque the "veil of the future" becomes. As a consequence we make daily operating plans in far more detail than those for next year, while those for next year are much more certain than our plans for ten years hence. The time-jointness system permits refinement of planning as the time span is reduced, yet insures consistency between short and long range plans. And of course, plans are usually made with the expectation that revisions will be necessary as new information becomes available.

Computation.—The objection might be made that the computations implied by the suggested method are much too involved. No detailed answer to such an objection will be attempted here—it should suffice to point out that modern econometric methods have progressed to the point where ten and fifteen equation systems are rather ordinary. Fifty equation systems have been solved, and the author knows of one project requiring the simultaneous solution of 100 equations. Compared with these latter models, the suggested method requires relatively little in the way of computation.

Goals or predictions?—What is perhaps the most penetrating question to be raised about the approach runs something as follows: If stumpage production is purely competitive, why worry about growth goals? Won't the competitive system automatically achieve these goals without anyone bothering to "predict" them?

Even though the stated assumptions are granted there seems little reason to suspect the goals would automatically be achieved—that they would, in fact, represent a

prediction of what will happen rather than a goal. In making his own plans each entrepreneur necessarily makes his own estimates of costs, prices, etc. For the model to yield a true *prediction*, either each producer would have to have identical expectations, or expectations of the different producers would have to compensate each other so as to yield fortuitously a result identical to that of the model.

Furthermore, the reader should recall that a discounting factor was used to make the different costs and revenues of different time intervals comparable. Nothing, however, was said about the magnitude of this discount factor. Higher interest rates make it profitable to cut present stands at the expense of future harvests, a fact fully reflected by the time-jointness approach. A different cutting pattern will result from every change in the discounting factor unless compensating variables are introduced. It would scarcely make sense to assume that all entrepreneurs would use identical interest rates or, for that matter, that public and private interest rates would be identical. For this reason, then, the goal determined by an agency having the welfare of future generations at heart (and therefore using a low discount rate) would diverge radically from goals determined by private operators who placed a high premium on present profit. Such divergence between goals points the way to needed policy decisions—if private operators are to meet public production goals, credit aids, insurance, etc., may all be required.

Conclusions

To be realistic any output pattern must be consistent with the production techniques and input schedules one assumes will be used. It must also be consistent with the political and social framework envisaged. If the pattern cannot be achieved within this framework we may wish to change either the output pattern or the political and social institutions themselves; if it is not compatible with technological relationships, we must either change the planned outputs or alter our production techniques; if it proves impossible to achieve a schedule of inputs that will yield a selected output, one or the other must be varied. Lacking this consistency, our production plan is not rational: our output plan becomes only an opinion, a wish, or a dream.

The time-jointness method has been presented as a means of placing national growth goal formulation in a rational production context. The system permits—in fact requires—the integration of both the physical and economic factors of forest production in establishing these goals. While presented as an alternative to current methods, in reality the approach is more than this, for it can be a powerful tool for analyzing the effect of institutional factors, and for determining the probable result of national policy decisions on output patterns over time. It offers a way of determining the realism of *any* output pattern however determined.

Lumber Production Up

United States lumber production for the first half of 1955 has been estimated by the National Lumber Manufacturers Association at 19,391,000,000 board feet. This is three percent above the first half of 1954. Softwood production was up 8 percent, but hardwood production declined 13 percent. The 19 billion-foot figure is the highest for the first half of any year in N.L.M.A.'s publication of production estimates.

Effects of Diameter, Crown Ratio, and Growth Rate on Gum Yields of Slash and Longleaf Pine[1]

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Diameter, crown-length ratio, and average ring width are useful criteria for estimating gum yields of slash and longleaf pine. The authors have computed estimated gum yields based on these criteria and use the results as evidence in favor of raising the present minimum diameter limit for turpentining on poorer than average sites.

THE EXTRACTION of gum from trees of slash pine (*Pinus elliottii*, Engelm.) and longleaf pine (*P. palustris*, Mill.) during a 5- or 10-year period preceding cutting augments the annual income per acre from timber of these species. So a gum naval stores operation should be included in any management plan for slash and longleaf pine if maximum income is to be obtained.

In managing stands of slash or longleaf pines for gum production, some estimate of the gum-yielding capacity of the stand is desirable before turpentining is started. Such estimates are especially valuable when stands are just coming into turpentining size because a small error in the estimated yield can mean the difference between a profit and a loss on the turpentining operation. Diameter, growth rate, and crown surface area are known to be correlated with gum yields. Wyman (*3*) demonstrated a correlation of gum yields with each of these factors, but without isolating the effects of the others. Hence, the separate effects of the three factors could not be determined from his study.

The purpose of the present study was to work out a combination of these factors which would give a reliable index of gum yields, and to show how such an index might be used to determine the stages in the rotation during which gum can be profitably extracted using the modern techniques of bark chipping and spraying of streaks with a sulfuric acid solution (*2*).

Untreated wood chipping was also included, to determine whether the effect of tree characteristics on gum yields was different for the two methods of chipping.

This study was made on only one site for each species with a streak height for bark chipping of 5/8 inch. Later tests showed that better results are obtained with streaks 3/4 inch high (*1*). This higher streak is now recommended for commercial practice. Hence the data presented here are of value only for the relative effects of the tree dimensions on gum yields.

Procedure

The trees selected for this study were located in the Osceola National Forest, Baker County, Florida. Mean age for the slash pines was 29 years and for longleaf pine 36 years. Site index for the slash pine area is 70 feet at 50 years. The longleaf pine area has a site index of 65 feet at 50 years. These sites are about average for the two species. Radial growth in the last inch averaged 8 rings on slash pine and 12 rings on longleaf pine.

This study was made on 130 trees of each species equally distributed in five 1-inch diameter classes covering a range of 9 to 14 inches. The 26 trees within each class were randomly assigned to the two treatments: weekly untreated chipping with streaks 1/2 inch high and 1/2 inch deep, and biweekly bark chipping with streaks 5/8 inch high treated with 50 percent sulfuric acid. Total gum yields for the 4-year period 1949-52, inclusive, were measured for each longleaf pine tree. On the slash pine trees, however, yields for only 3 years are available because of the high mortality in 1952 caused by the black turpentine beetle (*Dendroctonus terebrans*, Oliv.). These yields were used as the dependent variable in the regression analyses.

Tree measurements included diameter at breast height, total height, height to base of live crown, number of rings in last inch of radial growth, and age of every fifth tree. These measurements were made early in 1949 before chipping was started. For use in regression equations, the diameter measurements were unchanged, but the other measurements were converted to crown-length ratio, and average width of annual rings in the last inch of radial growth. Crown ratio was used rather than crown length because it takes into account the variation in height of individual trees.

Analysis of Data and Results

Black turpentine beetles killed some of the trees during the period of working, so data from these trees were discarded. The number of trees in each treatment with complete gum yield records is as follows:

Slash pine bark-chipped	49
Slash pine wood-chipped	51
Longleaf pine bark-chipped	56
Longleaf pine wood-chipped	58

Three sets of independent variables were used to derive equations for estimating gum yield using regression methods. These sets are:

1. Diamater
2. Diamater and crown-length ratio
3. Diameter and mean ring width in last inch of radial growth.

Each of these regressions is discussed separately.

Diameter

The correlation of diameter with gum yields in this study was highly significant. The relationships are shown in the following regression equations:

Slash pine with both turpentining treatments combined: Gum yield $= -210.2 + 36.37$ d.b.h.

Longleaf pine with bark-chipped, acid-treated streaks: Gum yield $= -83.37 + 25.64$ d.b.h.

[1]Acknowledgement is made to Albert G. Snow, Jr., who planned and established this study, and to Luther Thomas, who supervised the field crew in collecting the data.

Longleaf pine with untreated, wood-chopped streaks: Gum yield = −137.0 + 25.64 d.b.h.

Although the coefficients for the diameter factor in these equations were highly significant, they apply only to stands similar to those of this study. The use of these equations may not provide accurate estimates of gum yields on other stands because of probable differences in distribution of crown ratios with diameter within stands. In the slash pine stand where this study was made, the difference in estimated yield of a tree 9 inches in diameter based on diameter and mean crown-length ratio was 25 percent greater than the estimate based on diameter alone. This discrepancy results from the fact that many of the trees 9 inches in diameter had crown ratios of about 0.20 while most of the trees in the 13-inch diamater class had a crown ratio of about 0.40 to 0.50. This distribution of crown ratios with diameter is not constant for all stands. Hence the use of a regression line based on diameter alone for estimating gum yields cannot be recommended.

Diameter and Crown-Length Ratio

Both diameter and crown-length ratio had a highly significant effect on gum yield in the multiple regressions for three of the four species-treatment categories. The exception was untreated wood chipping on slash pine. The equations for the three categories in which both of the independent variables were significant are as follows:

Slash pine with bark-chipped, acid-treated streaks: Gum yield = −242.7 + 28.49 d.b.h. + 390.6 crown ratio;

Longleaf pine with bark-chipped, acid-treated streaks: Gum yield = −223.2 + 25.13 d.b.h. + 366.7 crown ratio;

Longleaf pine with wood-chipped, untreated streaks: Gum yield = −191.0 + 20.91 d.b.h. + 254.3 crown ratio.

In these equations, gum yields are expressed in number of barrels (435 lbs. each) per crop of 10,000 faces, diameter is in inches, and crown-length ratio is crown length divided by total height.

In longleaf pine, the difference in level between treatments was highly significant; but the differences between corresponding coefficients were not significant. Pooled coefficients were not used for the two treatments, however, because of the possibility that they might be significantly different in a larger sample.

The equations for yields obtained with bark-chipped and acid-treated streaks plotted in Figure 1 show that for either species a 10-percent increase in crown-length ratio will increase gum yields by about 38 barrels per crop for any diameter between 9 and 14 inches. For any crown-length ratio between 0.20 and 0.50, an increase in diameter of 1 inch will increase gum yields by about 27 barrels per crop.

Diameter and Mean Ring Width in Last Inch of Radial Growth

The regression equation involving diameter and average ring width in the last inch of radial growth does not increase the precision of the estimated gum yields over that obtained with diameter and crown-length ratio. This equation, however, may be applicable over a wide range of site quality because ring width is influenced by both stand density and site quality and hence may reflect some of the variation in both of these factors. This possibility, however, has not yet been tested. Crown-length ratio, on the other hand, is influenced primarily by stand density.

The equations are as follows:

Slash pine, bark-chipped, acid-treated trees: Gum yield = −241.3 + 28.44 d.b.h. + 1094 ring width.

Longleaf pine, bark-chipped, acid-treated trees: Gum yield = −190.1 + 26.66 d.b.h. + 1163 ring width.

Longleaf pine, untreated, wood-chipped trees: Gum yield = −156.2 + 21.66 d.b.h. + 738.5 ring width.

The coefficient for ring width was significant at the 1-percent level for slash pine and at the 5-percent level for each treatment on longleaf pine. The coefficient for ring width on untreated, wood-chipped slash pine was not significant.

These equations show that for an increase in average ring width of 0.01 inch in the last inch of radial growth, an increase in gum yields of about 11 barrels per crop is obtained with either species where bark-chipped, acid-treated streaks are used. Thus, if a tree were growing at a rate of 10 rings per inch (ring width = 0.1 inch) and a thinning increased radial growth by 0.01 inch per year, the number of rings in the next inch would be reduced to 9. The ratio of ring width increment to gum yield increment, however, applies to trees between 9 and 14 inches in diameter having ring widths ranging from 0.05 inch to 0.125 inch in longleaf pine and from 0.07 inch to 0.17 inch in slash pine. Gum yields computed from these equations are plotted in Figure 2.

The data show an interesting difference in gum yields between species when both are worked using bark-chipped, acid-treated streaks. If trees of both species are of the same diameter and increasing in diameter at the same rate, longleaf pine will yield about 50 more barrels of gum per crop than slash pine. This difference in gum yields is rarely found in practice, however, because longleaf pine is usually limited to the poorer sites where growth rate is slower than with slash pine on better sites.

With bark chipping and acid treatment, longleaf pine will generally yield more gum than slash pine even when longleaf is growing more slowly. This observation is the reverse of that reported by Wyman (*3*) on trees worked with the old method using untreated wood-chipped streaks. The explanation of this discrepancy lies in the fact that on longleaf pine, greater yields are obtained with biweekly bark chipping and acid treatment than with the older method of weekly untreated wood chipping. On slash pine, however, gum yields are about the same with the two methods, though the new method requires much less labor.

The percentages of the variation of gum yields accounted for by the three regressions are listed in Table 1. Diameter, the most easily mea-

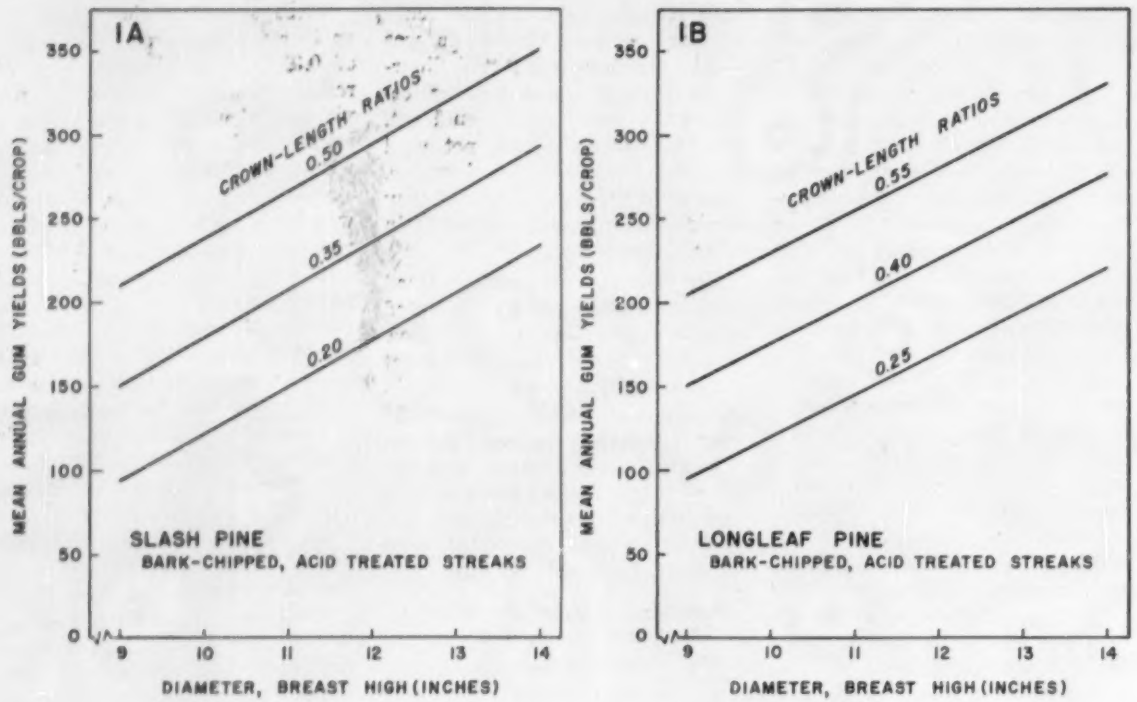

FIG. 1.—Regression lines for effect of diameter and crown-length ratio on gum yield. *A*, slash pine. *B*, longleaf pine. Middle line on each graph represents the mean crown-length ratio of the sample trees.

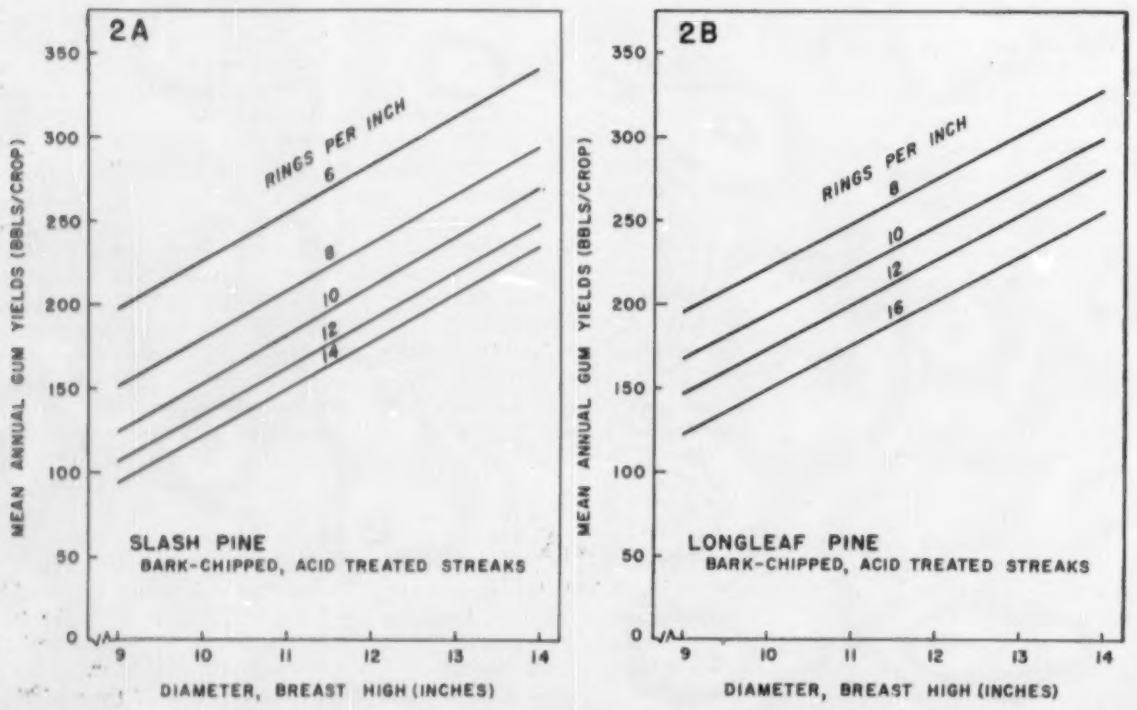

FIG. 2.—Regression lines for effect of diameter and number of rings in last inch of radial growth on gum yields. *A*, slash pine with mean of 8 rings per inch in sample. *B*, longleaf pine with mean of 12 rings per inch in sample.

sured variable, accounted for about 34 percent of the variation in gum yields. The addition of crown-length ratio to the diameter factor increased the precision of the regression by 12 percent in the sample used. Regression estimates of gum yield based on diameter and ring width were no better than those based on diameter and crown-length ratio. The precision of the estimates was greater with modern, bark chipping than with wood chipping, and was better on slash pine than on longleaf pine.

TABLE 1.—PERCENT OF VARIATION IN GUM YIELDS ACCOUNTED FOR BY REGRESSIONS

Independent variables	Slash		Longleaf		Averages
	Wood chipping	Bark chipping	Wood chipping	Bark chipping	
Diameter	41	48	21	24	34
Diameter and crown-length ratio	44	64	32	46	46
Diameter and ring width	42	63	27	34	42
Averages	42	58	27	35	41

Applicability of Data to Stand Management

The results of this study show that gum yields are correlated to some extent, with diameter. Obviously, maximum gum yields and maximum profit on gum can be obtained during the period preceding a final harvest cut when trees reach their maximum size. Gum extraction is also profitable ahead of intermediate cuttings in the later stages of stand development, but extraction of gum from trees to be taken in early thinnings for pulpwood may be a marginal operation. The result of this study can be used as a guide to show whether extraction of gum from smaller trees is profitable on sites comparable to those on which the data were collected.

The average break-even point for commercial gum production is not known. A complicating factor in determining this figure is the great variation in operational efficiency among gum producers. Some producers have stated that they can stay in business with yields of 175 barrels of gum per crop of 10,000 faces on their own timber. Other producers, working on leased timber, have said that 200 barrels per crop are needed. The difference between these two figures provides for a lease rate of 12.5 percent of the gross on a yield of 200 barrels. This yield appears to be a good general figure for adequate profit.

If we can accept this yield as the desirable minimum on leased timber, then the margin of profit is too small on any leased tree which yields less than 8.7 pounds of gum annually. Many small trees are being worked at a loss to maintain production volume on a particular area and the higher yields on the larger trees sometimes compensate for these losses. If gum extraction could be limited to trees which yield a minimum of 8.7 pounds of gum, then production of gum would be much more efficient and more profitable.

In the longleaf pine stand where this study was made the average crown-length ratio was 0.40, and average radial growth was at the rate of 12 rings in the last inch. To get a minimum of 8.7 pounds of gum per tree in this stand a minimum diameter of 11 inches would have been required. This high diameter would have been necessary because the 9- and 10-inch trees had small crowns.

The slash pine trees in this study had an average crown-length ratio of 0.35 and average radial growth rate of 8 rings in the last inch. To get a minimum of 8.7 pounds of gum per tree in this stand, a minimum diameter of 10.7 inches would have been required. Here again the 9-inch trees had crowns too small for adequate gum production.

These stands, in common with many other stands in the slash-longleaf pine type, included many trees in the 9- and 10-inch diameter class which had crown-length ratios of about 0.20 because of dense stocking.

It is apparent from Figures 1 and 2 that turpentining of such trees preceding a thinning will not yield the desired minimum of 200 barrels of gum per crop. Therefore, the thinning should be made promptly without being preceded by a turpentining operation.

In general, a heavy thinning from below in such stands will leave most, but not all, of the dominant and codominant trees. The trees remaining after such a thinning will soon, if not immediately, be capable of yielding 200 or more barrels of gum per crop. Only those trees marked for the next intermediate cut, however, should be worked for gum. A minimum of 20 turpentine faces per acre is feasible for commercial gum extraction, and an operable cutting for either saw logs or pulpwood usually requires more than 20 trees per acre. Hence, restricting turpentine faces to trees marked for cutting will permit a profitable naval stores operation.

The data presented here are useful only for sites comparable to those on which the study was made. Gum yield tables for the entire naval stores belt cannot be constructed until the effect of site differences on gum yield can be evaluated.

The evidence is rather convincing, however, that the present minimum diameter limit of 9 inches used in commercial turpentine operations should be raised to at least 10 inches on poorer than average sites if adequate profits are to be obtained.

Summary

Multiple regression estimates of gum yields from *Pinus elliottii*, Engelm., and *P. palustris*, Mill., showed, for trees with a diameter between 9 and 14 inches, that a 10-percent increase in crown-length ratio will increase gum yields by about 38 barrels (of 435 lbs. each) per crop of 10,000 trees. For any crown-length ratio between 0.20 and 0.50 an increase in diameter of 1 inch will increase gum yields by about 27 barrels per crop. For any diameter within the range 9 to 14 inches, an increase in average ring width of 0.01 inch in the last

inch of radial growth will increase gum yields by about 11 barrels per crop.

Data for computing the regression equations were obtained in a slash pine stand with a site index of 70 feet and in a longleaf pine stand with an index of 65 feet. Trees were turpentined using bark-chipped streaks 5/8-inch high which were treated with a 50-percent solution of sulfuric acid on a biweekly schedule. To get a minimum gum yield of 200 barrels per crop in these stands the required minimum diameter for turpentining is 10.7 inches for slash pine and 11.0 inches for longleaf pine. A thinning from below, in which most of the trees smaller than these specified diameters are removed, is recommended for such stands before turpentining is started.

The evidence clearly shows that the minimum diameter limit of 9 inches for turpentining should be raised to at least 10 inches to permit a profitable operation on poorer than average sites.

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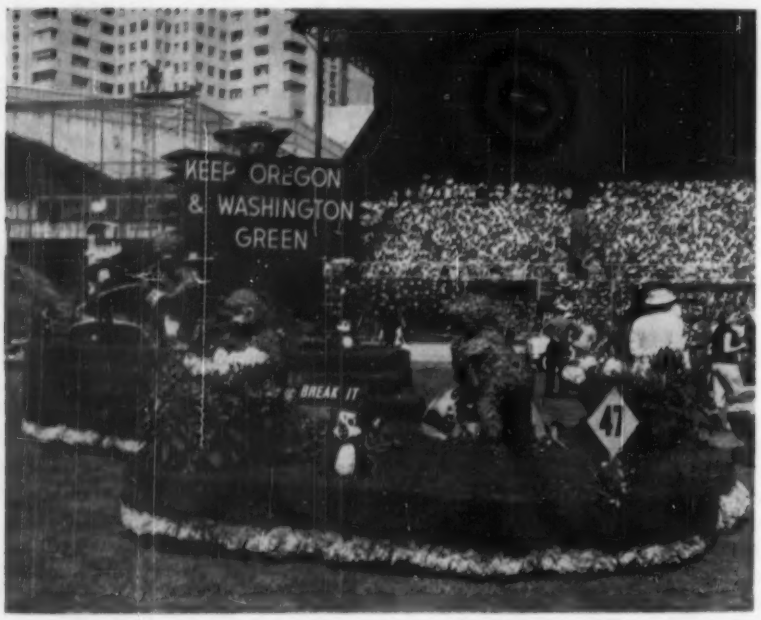

JOINT KEEP GREEN FLOAT WINS PRIZE IN ROSE FESTIVAL. Keep Oregon Green and Keep Washington Green combined efforts in the huge Portland Rose Festival Parade to produce the biggest forest fire prevention float ever seen in Portland, Oregon. A thirteen foot Smokey Bear, holding a sign "Keep Oregon and Washington Green" rode atop the thirty-five foot float. Three little bear cubs, one breaking a match, one crushing a cigarette, and one pouring water on a campfire carried the fire prevention message to the 400,000 people who witnessed the giant spectacle. Each year this float has been displayed in parades throughout the state of Washington by the Seattle Keep Washington Green Committee. This Committee which includes members of the WHPFFITPNW Club (We Help Prevent Forest Fires in the Pacific Northwest) travels to major community celebrations to carry the forest fire prevention message at every opportunity. The float and its unique group of sponsors have won twelve trophies or awards during the past four years. The Rose Festival marks the first time that the float has been sponsored by an adjacent state.

Seasonal Distribution of Radial and Leader Growth in the Sitka Spruce-Western Hemlock Forests of Southeast Alaska

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THE AMOUNT of seasonal growth of stands can be closely approximated by use of yield and volume tables or can be measured without much difficulty. The seasonal distribution of this growth is generally assumed to coincide with the warmer months and no additional emphasis is placed on its occurrence. Data on the seasonal distribution of the growth, however, may give a better understanding of the physiology of individual trees and species and may be useful in timing remeasurements and treating plots for specific purposes. This study was designed to determine the seasonal distribution of radial and leader growth and its general relationship to climatic factors in Southeast Alaska.

Method of Study

Radial growth measurements were first taken on a series of trees near Juneau in 1951 and a second series set up at Hollis, near Ketchikan, in 1952. Leader growth measurements were taken at Hollis in 1952 and repeated in 1953.

1951 Radial growth — Juneau area.—Ten mature old-growth trees and ten second-growth dominant trees, with five spruce (*Picea sitchensis*) and five hemlock (*Tsuga heterophylla*) in each group, were prepared for weekly dendrometer measurements using the dial gage dendrometer as described by Daubenmire.[1]

The experiment was set up on March 26. Weekly measurements were taken until November 29 when ice coated the bark. Weather data for the period were obtained from the U. S. Weather Bureau at the Juneau Airport, about a mile from the study area.

1952 Radial growth—Hollis.—Fourteen second-growth trees, consisting of five western hemlock, five Sitka spruce, and four western redcedar (*Thuja plicata*), and ten old-growth trees, consisting of five western hemlock and five Sitka spruce, were set up for weekly measurements on May 14, 1952. Measurements were discontinued on September 24. An additional series of three rapid growing second-growth Sitka spruce near the beach were measured daily. Weather data for the period were obtained from a weather station at Hollis.

1952 Leader growth—Hollis.—A series of six western hemlock and eight Sitka spruce saplings, ranging from 5 to 10 feet tall, were measured at weekly intervals from May 23 until September 17. Except for two spruce, all saplings were vigorous and had been making good leader growth. Measurements were referenced to an older limb. Leader growth on an upper and lower lateral branch was measured on two spruce and two hemlock.

1953 Leader growth—Hollis.—Leader growth measurements were continued on four spruce and five hemlock using the same leaders unless they had been damaged during the winter. New trees were selected in the same group wherever necessary.

Results

1951 Radial growth—Juneau.—Table 1 gives the weekly radial change for the trees of each species by age groups to the nearest ten thousandths of an inch. There was considerable variation in the amount of gain and loss within species and age groups although the trees tended to react similarly to climatic conditions.

In computing the growth percentages by weekly periods, the weekly reading nearest the average

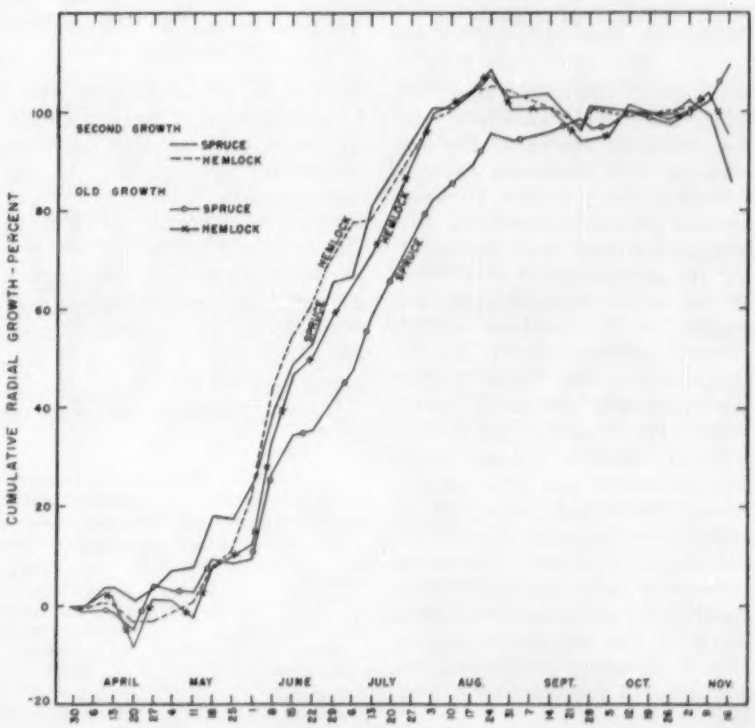

FIG. 1.—Cumulative radial growth in percent. Juneau, Alaska, 1951.

[1]Daubenmire, R. F. An improved type of precision dendrometer. Ecology 26: 97-98. 1945.

TABLE 1.— WEEKLY RADIAL CHANGES IN TEN THOUSANDTHS OF AN INCH AND PERCENTAGES BY SPECIES AND AGE GROUPS. JUNEAU, 1951

Period ending	Weekly growth				Weekly percent				Cumulative percent			
	2nd-growth		Old-growth		2nd-growth		Old-growth		2nd-growth		Old-growth	
	Spruce[1]	Hem.[2]	Spruce[3]	Hem.[4]	Spruce	Hem.	Spruce	Hem.	Spruce	Hem.	Spruce	Hem.
3/26	Established											
4/2	— 2	— 1	— 8	0	—.21	—.21	—.63	0	—.21	—.21	—.63	0
9	40	3	7	11	4.16	.64	.55	2.88	3.95	.43	—.08	2.88
13	0	2	—11	— 4	0	.43	—1.03	—1.05	3.95	.86	—.95	1.83
20	—27	—20	—40	—38	—2.81	—4.29	—5.06	—9.95	1.14	—3.43	—4.11	—8.12
27	26	2	104	37	2.70	.43	8.22	9.69	3.84	—3.00	4.11	1.57
5/4	32	9	—12	— 2	3.33	1.93	—.95	—.52	7.17	—1.07	3.16	1.05
11	4	8	— 1	—12	.41	1.71	—.08	—3.14	7.58	.64	3.08	—2.09
18	101	33	83	38	10.49	7.07	6.56	9.94	18.07	7.71	9.64	7.85
25	— 1	18	—12	9	—.11	3.85	—.94	2.36	17.96	11.56	8.70	10.21
6/1	71	51	14	9	7.38	10.92	1.10	2.36	25.34	22.48	9.80	12.57
8	135	101	122	76	14.02	21.63	17.55	19.89	39.36	44.11	27.35	32.46
15	88	50	91	54	9.13	10.71	7.20	14.14	48.49	54.82	34.55	46.60
22	50	31	15	16	5.20	6.64	1.18	4.19	53.69	61.46	35.73	50.79
29	118	46	78	28	12.25	9.85	6.17	7.33	65.94	71.31	41.90	58.12
7/6	9	31	77	25	.93	6.63	6.08	6.54	66.87	77.94	47.98	64.66
13	139	2	140	28	14.44	.43	11.07	7.33	81.31	78.37	59.05	71.99
20	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	200	78	—	—	15.81	20.42	—	—	74.86	92.41
8/3	186	96	91	27	19.31	20.56	7.20	7.07	100.62	98.93	82.06	99.48
10	2	6	48	6	.21	1.28	3.79	1.57	100.83	100.21	85.85	101.05
17	26	17	48	11	2.70	3.64	3.79	2.88	103.53	103.85	89.64	103.93
24	39	6	80	17	4.05	1.29	6.33	4.45	107.58	105.14	95.97	108.38
31	—44	— 5	—24	—31	—4.57	—1.07	—1.90	—8.12	103.01	104.07	94.07	100.26
9/7	—	—	—	—	—	—	—	—	—	—	—	—
14	9	—15	26	3	.94	—3.21	2.06	.79	103.95	100.86	96.13	101.05
24	—74	—13	18	—27	—7.69	—2.79	1.42	—7.07	96.26	98.07	97.55	93.98
28	47	13	—10	3	4.88	2.79	—.79	.78	101.14	100.86	96.76	94.76
10/5	— 7	— 3	10	2	—.72	—.65	.79	.53	100.42	100.21	97.55	95.29
12	— 4	— 4	36	23	—.42	—.85	2.85	6.02	100.00	99.36	100.40	101.31
26	— 6	3	—31	—11	—.62	.64	—2.46	—2.88	99.38	100.00	97.94	98.43
11/2	26	6	26	6	2.70	1.28	2.06	1.57	102.08	101.28	100.00	100.00
9	—31	— 4	30	16	—3.22	2.13	2.37	4.19	98.86	99.15	102.37	104.19
16	—111	—67	96	—34	—11.53	13.07	7.59	—8.90	87.33	86.08	109.96	95.29

[1]Based on 5 trees
[2]Based on 5 trees
[3]Based on 4 trees
[4]Based on 5 trees

termination diameter, as determined from several essentially uniform readings was used. The first observation of the season was considered to be the time at which seasonal growth was initiated. The termination dates used in computing the percentages were October 12 for spruce second-growth, November 9 for hemlock second-growth, and November 11 for the old-growth species. Figure 1 shows the cumulative percent of weekly growth by species and age group.

Trunk diameter changes which occurred before and after positive growth began and ended are attributed to changes in the moisture content of the trunk. Continuous increase in radial size began about April 15 for second-growth spruce, April 23 for old-growth spruce, May 11 for second-growth hemlock, and May 13 for old-growth hemlock.

The grand period of growth, defined as the period between which 5 and 95 percent of the total growth was made, began on May 1 for second-growth spruce, May 15 for second-growth hemlock, May 14 for old-growth spruce, and May 16 for old-growth hemlock. The grand period terminated on July 27 and 29 for second-growth spruce and hemlock, respectively, on July 30 for old-growth hemlock, and August 22 for old-growth spruce.

Growth terminated on September 15 for all species and age groups except for old-growth spruce which terminated on October 12. During August and the early part of September the radius of all species and age groups, except old-growth spruce, were greater than on the average termination date. This condition is thought to be associated with changes in the moisture content within the tree, rather than directly connected with the growth process.

TABLE 2.—NUMBER AND PERCENT OF THE TOTAL NUMBER OF GROWING DAYS BY PERIODS. JUNEAU, 1951

	Pre-grand period		Grand period				Post-grand period		Total days
			First half		Last half				
	Days	%	Days	%	Days	%	Days	%	
Second-growth									
Spruce	16	10	47	31	40	26	50	33	153
Hemlock	4	3	27	21	48	38	48	38	127
Old-growth									
Spruce	21	12	54	31	46	27	51	30	172
Hemlock	3	2	37	30	38	30	47	38	125

TABLE 3.—WEEKLY RADIAL CHANGES IN TEN THOUSANDTHS OF AN INCH AND PERCENTAGES BY SPECIES AND AGE GROUPS HOLLIS, 1952

Period ending	Weekly growth					Weekly percent					Cumulative percent				
	2nd-growth			Old-growth		2nd-growth			Old-growth		2nd-growth			Old-growth	
	Spruce[1]	Hem.[2]	Cedar[3]	Spruce[1]	Hem.[2]	Spruce	Hem.	Cedar	Spruce	Hem.	Spruce	Hem.	Cedar	Spruce	Hem.
5/14	Established														
21	31	53	70	24	22	6.87	12.44	6.96	4.13	14.19	6.87	12.44	6.96	4.13	14.19
28	—12	12	32	—1	—26	—2.66	2.82	3.18	—.17	—16.77	4.21	15.26	10.14	3.96	—2.58
6/4	14	41	42	18	11	3.10	9.62	4.18	3.10	7.10	7.31	24.88	14.32	7.06	4.52
11	14	30	46	12	6	3.10	7.04	4.58	2.06	3.87	10.41	31.92	18.90	9.12	8.39
18	54	46	98	35	19	11.97	10.80	9.75	6.02	12.26	22.38	42.72	28.65	15.14	20.65
26	40	36	107	51	10	8.87	8.45	10.65	8.78	6.45	31.25	51.17	39.30	23.92	27.10
7/2	79	55	155	96	33	17.52	12.91	15.42	16.52	21.29	48.77	64.08	54.72	40.44	48.39
9	49	20	63	64	6	10.86	4.69	6.27	11.02	3.87	59.63	68.77	60.99	51.46	52.26
16	59	18	99	36	11	13.08	4.22	9.85	6.20	7.10	72.71	72.99	70.84	57.66	59.36
23	30	10	60	65	2	6.65	2.35	5.97	11.19	1.29	79.36	75.34	76.81	68.85	60.65
30	37	25	73	46	9	8.20	5.87	7.26	7.92	5.81	87.56	81.21	84.07	76.77	66.46
8/6	36	29	61	54	17	7.98	6.81	6.07	9.29	10.97	95.54	88.02	90.14	86.06	77.43
13	—9	5	36	—1	—8	—2.00	1.17	3.58	—.17	—5.16	93.54	89.19	93.72	85.89	72.27
20	44	44	76	65	29	9.76	10.33	7.56	11.19	18.71	103.30	99.52	101.28	97.08	90.98
27	—7	—3	—20	—1	—2	—1.55	—.70	—1.99	—.17	—1.29	101.75	98.82	99.29	96.91	89.69
9/2	—37	—22	—50	—17	—14	—8.20	—5.16	—4.98	—2.93	—9.03	93.55	93.66	94.31	93.98	80.66
10	37	30	76	29	23	8.20	7.04	7.56	4.99	14.84	101.75	100.70	101.87	98.97	95.50
17	9	10	4	17	12	2.00	2.35	.40	2.92	7.74	103.75	103.05	102.27	101.89	103.24
24	—17	—13	—23	—11	—5	—3.75	—3.05	—2.29	—1.89	—3.24	100.00	100.00	100.00	100.00	100.00

[1]Based on 5 trees
[2]Based on 5 trees
[3]Based on 4 trees

Table 2 shows that in both age groups hemlock growth for each period occurred over a shorter period than spruce growth. During the grand period the rate of growth changed slightly. Spruce in both age groups grew at a faster rate during the latter part of the period and second-growth hemlock grew at a faster rate during the first part of the grand period. Old-growth hemlock grew at a fairly consistent rate throughout this period.

The peak weekly growing period in all groups occurred between June 1 to 8 except second-growth spruce which occurred between July 6 and 13. These peaks ranged from 15 percent of the total growth for second-growth spruce to 22 percent for second-growth hemlock. Old-growth spruce and hemlock averaged 18 and 20 percent respectively.

1952 Radial growth—Hollis.—The Hollis dendrometer measurements were started on May 14, about two weeks after the buds began to open, and continued until September 24. Table 3 gives the growth by weekly periods, both periodic and cumulative, in ten thousandths of an inch and by percentages, for the period of observation. The last observation was taken as the average termination diameter in computing the percentages. Figure 2 shows the cumulative radial growth by percent for the average of each species and age group.

Continuous increase in radius continued from the first measurement on May 14. Extension of the curves would indicate that growth possibly began from one to two weeks earlier. For this report, however, the first reading is used at the beginning of growth for the percentage computations.

The grand period of growth began May 16 in hemlock and May 22 in cedar second-growth, May 31 in old-growth spruce, June 1 in second-growth spruce, and June 5 in old-growth hemlock. The grand period terminated August 14 in second-growth spruce, August 17 for old-growth spruce and second-growth hemlock, August 27 in second-growth cedar, and September 9 in old-growth hemlock. Growth was considered as terminated on September 24 for all species and both age groups.

Table 4 summarizes the number and percent of the total number of growing days by periods.

Table 4 shows that spruce made the greatest portion of growth in fewer days than either hemlock or cedar, although growth before and after the grand period was more prolonged. The proportions, however, may be slightly biased as they are based on the same number of growing days. As shown by the growth curve in Figure 2, redcedar does not show a definite growth cessation as does spruce and hemlock. During the grand period of growth the rates of all age groups

TABLE 4.—NUMBER AND PERCENT OF THE TOTAL NUMBER OF GROWING DAYS BY PERIODS. HOLLIS, 1952.

	Pre-grand period		Grand period				Post-grand period		Total days
			First half		Last half				
	Days	%	Days	%	Days	%	Days	%	
Second-growth									
Spruce	18	13	33	25	41	31	41	31	133
Hemlock	2	1	39	29	54	41	38	29	133
Cedar	8	6	40	30	57	43	28	21	133
Old-growth									
Spruce	17	13	37	28	41	31	38	28	133
Hemlock	22	17	36	27	60	45	15	11	133

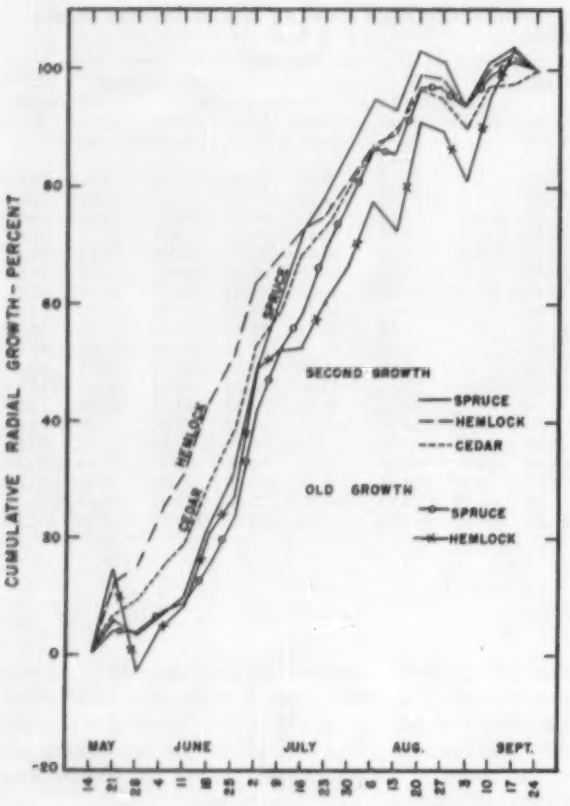

FIG. 2.—Cumulative radial growth in percent. Hollis, Alaska, 1952.

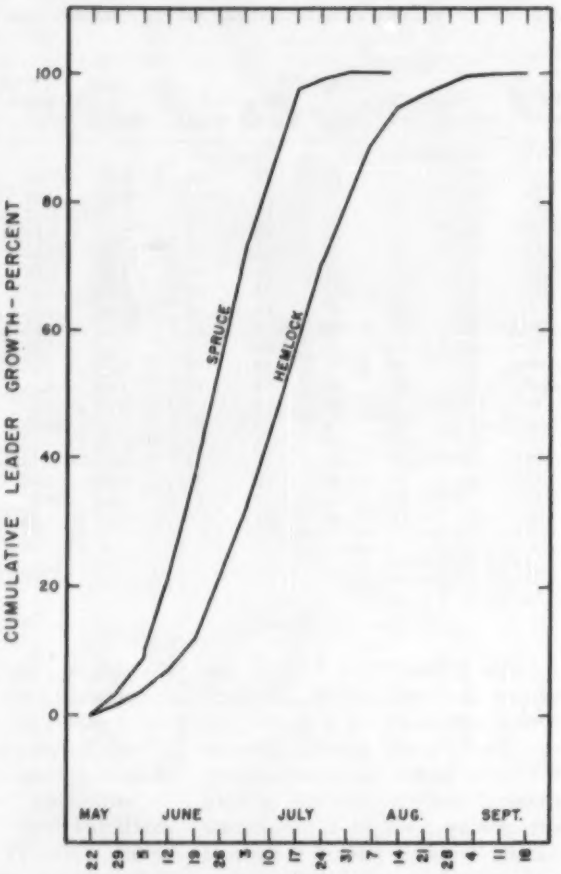

FIG. 3.—Cumulative leader growth by species, in percent. Hollis, Alaska, 1952.

and species changed very little, as is shown by the number of days in which each half of the grand period growth was made.

The peak weekly growing period in both age groups and for all species occurred during the week of June 26 to July 2. During this period growth averaged 13 percent for second-growth hemlock, 15 percent for cedar second-growth, 18 percent for spruce second-growth, 17 percent for spruce old-growth, and 21 percent for hemlock old-growth.

1952 Leader growth—Hollis.—Leader growth on saplings located in the same vicinity was measured during the same period as the above radial measurements. Table 5 summarizes the growth in feet and by percentages for the season. As in radial growth there was variation between individual trees for no apparent reason.

Measurements began on May 23, estimated to have been about one week after the buds began swelling. In all cases the length had increased less than .02 feet as estimated from nearby buds in a more or less dormant state. The first measurements were considered as the initiation of leader growth for computing the percentage data. Figure 3 shows the cumulative growth in percent by weekly periods.

The average termination date of leader growth was August 6 for spruce and September 17, six weeks later, for hemlock. Spruce grew more rapidly than hemlock, the peak weekly leader growth, about 19 percent of the seasonal total, occurring between June 19 and 26. The peak hemlock leader growth, about 14 percent of the seasonal total, occurred between July 10 and 17 or about three weeks later than spruce.

Fifty-one percent of the total spruce leader growth was made during the three weeks of June 13 to July 3 with 90 percent being completed in the seven weeks from May 30 to July 17. Fifty-eight percent of the hemlock leader growth occurred in the five weeks from June 27 to July 30 with 90 percent being completed in the ten weeks from June 13 to August 20.

Leader growth on the two spruce on a very poor wet site is not included with the above data. On these two trees growth began one week later and terminated by July 10—a period of 6 weeks. The reduced growth on the poor site may be due to a low reserve food supply.

Leader growth on upper and lower laterals was observed on only

two hemlock and two spruce. An upper lateral on one hemlock and a lower lateral on the other hemlock were broken during the observation. In general, from these 4 trees, lateral leader growth began about the same time as the terminal leader growth. The leader growth on the upper laterals terminated about one week earlier in spruce and two weeks earlier in hemlock than the terminal leader growth. The lower laterals generally terminated growth from 3 to 6 weeks earlier.

Bud opening varied with elevation. On July 26, when leader growth was nearly two-thirds complete on hemlock at lower elevations, buds were just opening near the timberline (about 2,000 feet) on the south slope of Harris Mountain.

1953 Leader growth—Hollis.— The first measurements were taken on May 15, about one week after growth activity had started. The bud elongation was measured and recorded at this observation and is assumed to represent approximately one week's growth. Figure 4 and Table 6 summarize the growth in feet and by percentages for weekly periods.

The average termination date of leader growth was August 1 for spruce. Hemlock still showed slight elongation on two of the five trees when measurements were terminated on August 16. However, this date is used as the termination date for calculation of percentages in Table 6.

Two consecutive weekly observations were missed during the early season and have been prorated in from the cumulative growth curve by species and comparison with the 1952 data.

Spruce again grew more rapidly than hemlock, the peak weekly leader growth, about 18 percent of the seasonal total, occurring between June 6 and 15. The peak hemlock leader growth, about 15 percent of the seasonal total, occurred between July 5 and 12, or about 4 weeks later than spruce.

In 1953, spruce leader growth showed less tendency toward a growth climax than in 1952 with

TABLE 5.—WEEKLY LEADER GROWTH IN FEET AND CUMULATIVE PERCENTAGE BY SPECIES. HOLLIS, 1952

Week ending	Sitka spruce[1] Growth[2]	Sitka spruce[1] Percent	Hemlock[1] Growth[2]	Hemlock[1] Percent	Cumulative growth percent Spruce	Cumulative growth percent Hemlock
May 23						
May 29	.04	3.79	.02	1.80	3.79	1.80
June 5	.05	4.74	.02	1.80	8.53	3.60
June 12	.13½	12.80	.03½	3.16	21.33	6.76
June 19	.16½	15.64	.05½	4.95	36.97	11.71
June 26	.20	18.95	.11	9.91	55.92	21.62
July 3	.17½	16.59	.12	10.81	72.51	32.43
July 10	.12½	11.85	.12½	11.26	84.36	43.69
July 17	.13½	12.80	.15½	13.97	97.16	57.66
July 24	.02	1.89	.14	12.61	99.05	70.27
July 30	.01	0.95	.10½	9.46	100.00	79.73
Aug. 6	.00	.00	.09½	8.56	100.00	88.29
Aug. 13	.00	.00	.06½	5.85	100.00	94.14
Aug. 20	.00	.00	.03	2.71	100.00	96.85
Aug. 27	.00	.00	.01½	1.35	100.00	98.20
Sept. 2	.00	.00	.01½	1.35	100.00	99.55
Sept. 10	.00	.00	.00½	.45	100.00	100.00
Sept. 17	.00	.00	.00	.00	100.00	100.00
TOTAL	1.05½		1.11			

[1]Average of 4 spruce and 6 hemlock.
[2]Growth in hundredths of feet.

TABLE 6.—WEEKLY LEADER GROWTH IN FEET AND CUMULATIVE PERCENTAGE BY SPECIES. HOLLIS, 1953

Week ending	Sitka spruce[1] Growth[2]	Sitka spruce[1] Percent	Hemlock[1] Growth[2]	Hemlock[1] Percent	Cumulative growth percent Spruce	Cumulative growth percent Hemlock
May 15	.04	3.01	.01	.78	3.01	.78
May 23	.05	3.76	.01	.78	6.77	1.56
May 30	.14½	10.90	.05	3.89	17.67	5.45
June 6	.16½	12.41	.08	6.23	30.08	11.68
June 15	.24	18.04	.13½	10.50	48.12	22.18
June 22	.14	10.53	.15½	12.06	58.65	34.24
June 27	.15	11.28	.13	10.12	69.93	44.36
July 5	.17	12.78	.18½	14.40	82.71	58.76
July 12	.19	14.28	.19½	15.18	96.99	73.94
July 19	.02½	1.88	.14	10.89	98.87	84.83
July 26	.01	.75	.11	8.56	99.62	93.39
Aug. 1	.00½	.38	.04	3.11	100.00	96.50
Aug. 8	.00		.02½	1.94	100.00	98.44
Aug. 16	.00		.02	1.56	100.00	100.00
TOTAL	1.33	100.00	1.28½	100.00		

[1] Average of 5 spruce and 5 hemlock.
[2] Growth in hundredths of feet.

TABLE 7.—SIGNIFICANT DIFFERENCES IN TRUNK DIAMETER CHANGES BETWEEN CLASSES OF DAYS

	Mean[1]	Clear 4	3-5 9	6-9 12	6-9 With rain 2	Overcast 13
Overcast with rain	28	**	**	**	*	**
Overcast	13	*	NS	NS	*	
6-9 tenths cloudy with rain	2	NS	NS	NS		
6-9 tenths cloudy	12	NS	NS			
3-5 tenths cloudy	9	NS				

[1]In ten-thousandths of an inch.
**Significant at 1% level.
*Significant at 5% level.
NS Not significant.

TABLE 8.—DATES BY WHICH INDICATED PERCENTAGE OF RADIAL GROWTH HAD BEGUN. JUNEAU 1951

Radial growth	Second-growth		Old-growth	
	Spruce	Hemlock	Spruce	Hemlock
Percent	*Date*			
0	April 15	May 11	April 23	May 13
5	May 1	May 15	May 14	May 16
50	June 17	June 11	July 7	June 22
95	July 27	July 29	Aug. 22	July 30
100	Sept. 15	Sept. 15	Oct. 12	Sept. 15
Peak weekly period	July 6-13	June 1-8	June 1-8	June 1-8

TABLE 9.—DATES BY WHICH INDICATED PERCENTAGE OF RADIAL GROWTH HAD BEGUN. HOLLIS, 1952

Radial growth	Second-growth			Old-growth	
	Spruce	Hemlock	Cedar	Spruce	Hemlock
Percent	*Date*				
0	May 14	May 14	May 14	May 14	May 14
5	June 1	May 16	May 22	May 31	June 5
50	July 4	June 24	July 1	July 7	July 11
95	Aug. 14	Aug. 17	Aug. 27	Aug. 17	Sept. 9
100	Sept. 24	Sept. 24	Sept. 24	Sept. 24	Sept. 24
Peak weekly period	June 26-July 2	June 26-July 2	June 26-July 2	June 26-July 2	June 26-July 2

TABLE 10.—DATES BY WHICH INDICATED PERCENT OF LEADER GROWTH HAD BEGUN. HOLLIS, 1952 AND 1953

Leader growth Hollis, 1952	Second-growth		Leader growth Hollis 1953	Second-growth	
	Spruce	Hemlock		Spruce	Hemlock
Percent	*Date*		*Percent*	*Date*	
0	May 23	May 23	0	May 9	May 11
5	May 30	June 9	5	May 19	May 30
50	June 23	July 14	50	June 16	June 30
95	July 17	Aug. 17	95	July 11	July 28
100	Aug. 6	Sept. 17	100	Aug. 1	Aug. 15
Peak weekly period	June 19-June 26	July 10-July 17		June 6-June 15	July 5-July 12

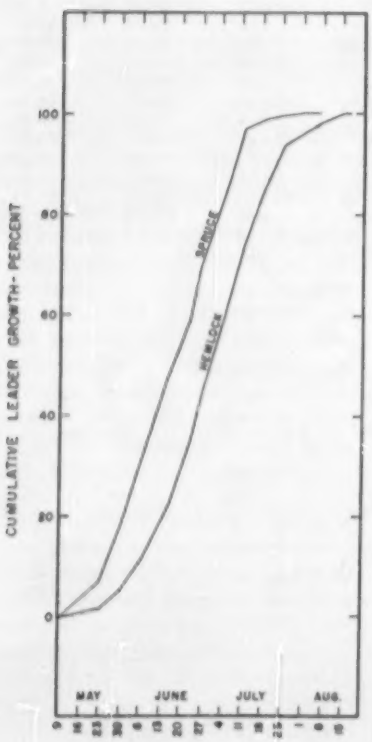

FIG. 4.—Cumulative leader growth by species, in percent. Hollis, Alaska, 1953.

about 50 percent of the seasonal growth occurring over a four-week period. Ninety percent of the seasonal growth, however, was completed in the seven weeks from May 23 to July 12, very similar to the 1952 season.

About 50 percent of the hemlock seasonal leader growth occurred over the four week period from June 15 to July 12 with nearly 90 percent occurring from May 30 to July 26, an eight-week period.

Leader growth on upper and lower laterals was observed on two hemlock and two spruce this year. Growth began about the same time on the laterals as on the terminal leader and terminated at the same time or possibly about a week earlier on the spruce.

Growth and Climatic Relationship

Warrack and Joergensen[2] summarize the causes of daily radial fluctuations as being largely due to "continuously alternating dehydration and rehydration of cell tissues." They state that "It has been thus shown that temperature has little, if any, direct influence on daily fluctuations of stem diameter. Indirectly, however, it must be considered one of the main factors as temperature is intimately linked with moisture relationship of the entire nature complex." Most seasonal growth investigations have been carried out in regions where soil moisture has been a limiting factor. In Southeast Alaska, however, soil moisture is rarely limiting and it is felt that the amount of atmospheric moisture, as it affects the water content of the trunk, is the most important cause of daily and periodic fluctuations.

In this study, based on daily measurements on three spruce, there was a general trend—but not a significant relationship—between temperature, precipitation and periodic growth. In general, when the temperature rose precipitation was less and the stems tended to shrink or dehydrate. When temperature fell, precipitation usually increased and the stems swelled or rehydrated. However, several other factors affect stem fluctuations, such as wind movement, exposure, light intensity, and soil temperature, so that temperature and moisture do not correlate closely with periodic growth even for daily periods. There was usually less correlation by weekly periods as conditions on the day the readings were taken would differ from the weekly average. The relationship of stem fluctuation to nearly identical consecutive days of temperature and precipitation varied. The greatest stem diameter change occurred on the first day with minor fluctuations on the following days.

[2]Warrack, G., and Chr. Joergensen. Precision measurement of radial growth and daily radial fluctuations in Douglas-fir. The For. Chronicle 26 (1): March. 1950.

The magnitude of daily radial changes varied from a shrinkage of over two-thousandths to a swelling of over seven-thousandths of an inch. The greatest swelling occurred on an overcast day with a half-inch of rain following a partly cloudy day. The greatest shrinkage occurred on a clear day following a partly cloudy day. Grouping of days into broad groups, as days overcast with rain, overcast, 6 to 9 tenths cloudy with rain, 6 to 9 tenths cloudy, 3 to 5 tenths cloudy, and clear days, gave significant differences in trunk diameter changes. Table 7 shows the mean radial change and significance of the difference of the means between these classes of days.

As Table 7 shows there was a real difference between days overcast with rain and all other classes of days and between overcast, clear, and 6 to 9 tenths cloudy with rain. Between other groups of days the differences were not significant because of large daily variations.

Growth summary.—Tables 8 to 10 summarize radial and leader growth for the Juneau and Hollis areas by dates of beginning of certain percentages of the growth.

Reproduction of Upland, Cutover Spruce—Balsam—Hardwood Stands in Minnesota[1]

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Former graduate students, University of Minnesota School of Forestry, now on active duty with the U. S. Navy and the U. S. Army, respectively.

THE IMPORTANCE of the white spruce (*Picea glauca*)—balsam fir (*Abies balsamea*)—hardwood type[3] in the pulpwood economy of the Lake States Region is difficult to overemphasize. White spruce and balsam fir found in this type are important sources of the long-fibered wood essential to the production of high quality pulp. Substantial amounts of quaking aspen are also found in the type. Present high demands for these three species are not expected to decline and the importance of promptly regenerating cutover stands is at once apparent.

Two recent studies of the status and extent of natural reproduction in upland, cutover white spruce—balsam fir—hardwood stands have been conducted in north-central Minnesota[4]. The first of these studies was made during the summer of 1952 (*3*); the second (*1*) the following summer.

Description of Field Methods

All field data were gathered in Koochiching and Itasca Counties. Areas sampled were confined to the spruce-balsam land type which typically occupies transition areas between the peat swamps and low, gravelly ridges so characteristic of north-central Minnesota. State and private cutting records were used to confine all sampling to areas which had been commercially clearcut from 6 to 12 years prior to investigation.

Due to the heterogeneity of the type and variability in size of cutover areas it was felt that, applied to a large area, a sufficiently random sample of stocking conditions would be obtained using the following design: The sampling unit was a linear combination of 10 mil-acre quadrats forming a plot 66 feet long and 6.6 feet wide. Plots were arranged in strip transects crossing cutover areas at right angles to any systematic soil disturbance (skid roads, haul roads, etc.) visible on existing aerial photographs. These photographs were taken subsequent to the most recent cutting date included in either study. Transects were begun at least 5 chains inside of the cutover area to eliminate possible edge effects.

Any quadrat containing at least one seedling, sucker, layer, or sprout was considered stocked. When more than one stem of reproduction fell within a quadrat that stem which the investigator considered most apt to survive and mature was recorded as the "best specimen" of reproduction. Each best specimen was tallied by species, height, and time and character of origin. Each best specimen was also rated good, fair, or poor as to vigor and estimated survival chance. For each quadrat, the following were also recorded: Total number of all reproduction stems by species; diameter and species of all stumps and residual trees; degree of coverage by overstory crowns, brush, slash, and lesser vegetation; damage or disturbance by natural and artificial agencies.

In an attempt to reconstruct the original stands all stumps and residual trees within a 1/20-acre rectangular plot (66 feet long by 33 feet wide) were tallied by species and diameter. One 1/20-acre plot was centered on and included each linear reproduction plot. Stems 3 inches d.b.h. and over were considered as residual trees.

Discussion of Data

Comparison of the separate results of the two summers' work (Table 1) indicates clearly the sim-

[1]Scientific Journal Series Paper No. 3234 of the University of Minnesota Agricultural Experiment Station.

[2]The writers are indebted to Professor Arthur E. Schneider of the University of Minnesota School of Forestry for his helpful advice and criticism during the conduct of the field work and the preparation of the manuscripts.

[3]This corresponds to Type 36 as defined in *Forest Cover Types of North America*, the report of the Society of American Foresters' Committee on Forest Types, 1954.

[4]Both studies were conducted under the auspices of the University of Minnesota School of Forestry and were made possible by the Minnesota and Ontario Paper Company Graduate Research Fellowship in Forestry.

TABLE 1.—COMPARISON OF FINDINGS FROM TWO REPRODUCTION STUDIES IN CUTOVER WHITE SPRUCE-BALSAM FIR-HARDWOOD STANDS IN NORTH-CENTRAL MINNESOTA

Estimated survival chance of best specimen of reproduction	Quadrat stocking—Percent 1952 data	1953 data	Combined data
Good	72.8	70.4	71.9
Fair	8.8	8.7	8.7
Poor	3.9	4.5	4.2
Total	85.5	83.6	84.8
Average number of stems per acre—all species	4,553	4,928	4,701
Total number of quadrats examined	2,060	1,340	3,400

TABLE 2.—SPECIES COMPOSITION OF THE REPRODUCTION STAND IN TERMS OF QUADRAT STOCKING[1]

Species	Quadrats containing indicated species: Number	Percent of total	Quadrats containing indicated species as best specimen of reproduction: Number	Percent of total	Quadrats containing indicated species as best specimen of reproduction with a good survival chance: Number	Percent of total
Balsam fir (*Abies balsamea*)	1,974	58.0	1,033	30.6	823	24.2
White spruce (*Picea glauca*)	310	9.1	110	3.2	88	2.6
Black spruce (*Picea mariana*)	75	2.2	38	1.0	32	0.9
White pine (*Pinus strobus*)	92	2.7	20	0.6	6	0.2
Norway pine (*Pinus resinosa*)	10	0.3	1	—	1	—
Jack pine (*Pinus banksiana*)	3	0.1	2	0.1	2	0.1
Cedar (*Thuja occidentalis*)	75	2.2	9	0.3	1	—
Tamarack (*Larix laricina*)	4	0.1	—	—	—	—
Quaking aspen (*Populus tremuloides*)	1,141	33.5	908	26.7	825	24.3
White birch (*Betula papyrifera*)	550	16.2	244	7.2	231	6.8
Black ash (*Fraxinus nigra*)	642	18.9	285	8.4	237	7.0
Balsam poplar (*Populus balsamifera*)	277	8.1	169	5.0	154	4.5
American elm (*Ulmus americana*)	176	5.2	39	1.1	29	0.8
Maple (*Acer* spp.)	4	0.1	3	0.1	3	0.1
Oak (*Quercus* spp.)	69	2.0	15	0.4	11	0.3

[1]Based on the total number of quadrats (3,400) studied during the course of both summers' work.

TABLE 3.—COMPARISON OF SPECIES COMPOSITION IN CUTOVER WHITE SPRUCE-BALSAM FIR-HARDWOOD STANDS BEFORE AND FROM 6 TO 12 YEARS AFTER CUTTING

Species	Cutover stand[1]: Stems per acre	Percent of total	Reproduction stand[2]: Stems per acre[3]	Percent of total
Balsam fir	163	48.2	242	33.7
White spruce	40	11.8	26	3.6
Pine	7	2.1	3	0.4
Other conifers[4]	20	5.9	9	1.3
Quaking aspen	60	17.8	243	33.7
Paper birch	24	7.1	68	9.5
Other hardwoods	24	7.1	128	17.8

[1]Reconstructed from 340 one-twentieth acre plots.
[2]Based on 3,400 mil-acre quadrats.
[3]Includes only best specimens of reproduction with a good survival chance.
[4]Northern white-cedar, tamarack, black spruce.

ilarity of the findings. The results are especially interesting in that two different investigators obtained strikingly similar results using a subjective scheme of reproduction vigor and survival chance classification.

A combination of all items of reproduction showed an average of 4,700 stems per acre with the species composition shown in Table 2. The apparent thrift of reproduction observed is indicated by the survival chance ratings recorded in Tables 1 and 2. Analysis of vigor ratings given the 2,443 best specimens of reproduction showed that 2,091 rated good, 331 fair, and 21 poor. Twenty of the 21 poor ratings were given to quaking aspen partially defoliated by the forest tent caterpillar (*Malacosoma disstria*). A balsam fir best specimen received the remaining poor vigor rating.

Considering only those best specimens of reproduction having an estimated good chance of survival, 81 percent were more than 4½ feet high at the time of investigation. Less than 5 percent were under 12 inches in height and almost all of these were either balsam fir or white spruce. At least in the cases of balsam fir and white spruce the preponderance of best specimens in the upper height classes is a direct indication of the importance of advance reproduction. Fifty-one percent of all balsam fir and almost half of the white spruce best specimens originated prior to logging.

Using data from the 1/20-acre plots to reconstruct the cutover stands it was found that the average d.b.h. had been 8.2 inches and that basal area had averaged 123 square feet per acre, all species combined. According to yield tables prepared by Gevorkiantz and Olsen (*2*), normal stocking for spruce-balsam-hardwood stands with an average d.b.h. of 8.2 inches amounts to 175 square feet of basal area per acre. This means that the cutover stands, as reconstructed, were 70 percent stocked at the time of logging.

A comparison of the species composition of the cutover and reproduction stands is presented in Ta-

ble 3. Figures for the reproduction stand are based solely on the best specimens of reproduction which received a survival chance rating of good. By deleting best specimens with a fair or poor survival chance rating an attempt is made to allow for expected mortality in the reproduction stand.

On half of the quadrats where the best specimen of reproduction was one of the hardwood species, either balsam fir or white spruce seedlings were also present. The number of spruce and balsam stems ranged from 1 to more than 25, with the average being approximately 4, per quadrat. It is quite probable that some of these understory spruce and balsam will mature and reach merchantable size either before or following release by the next cut.

Conclusions

Natural regeneration in the upland, cutover white spruce-balsam fir-hardwood stands examined is considered to be at least adequate, both in numbers and distribution. Balsam fir and quaking aspen are the most abundant species in the young stands. The proportion of white spruce has declined and all other coniferous species, with the sole exception of balsam fir, have virtually disappeared. Hardwood yields, particularly with respect to quaking aspen, are expected to be considerably greater than in the past and the combined yields from balsam fir and white spruce should equal the corresponding yields of the last cut. If potential pulpwood volumes of existing understory spruce and balsam fir can be realized, the total amount of softwood available for future cuts will rise accordingly.

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Survey Shows About One-Third of New York's Land Area Covered by Commercial Forests

More than one-third, or approximately 12 million acres, of New York's total land area is covered with commercial forests which contain about 25½ billion board feet of saw timber according to a report issued by the U. S. Department of Agriculture.

The report is based on a survey made by the Northeastern Forest Experiment Station of the Forest Service, in cooperation with the New York State Conservation Department.

Nearly 19 billion board feet of New York's saw timber is in hardwoods, according to the survey. Of this, 9.8 billion board feet is in northern hardwoods, such as maple, birch, beech, and ash. Of the 6½ billion board feet of softwood saw timber, about 4.6 billion are equally divided between hemlock and white pine. The remaining softwood saw timber is in spruce and fir.

Most of the commercial forest land is not heavily stocked with saw timber. Only 12 percent has stands averaging 5,000 board feet or more per acre. About 26 percent contains stands of 1,500 to 5,000 board feet per acre. The remaining 62 percent carries little or no saw timber.

A copy of the report may be obtained from the Northeastern Forest Experiment Station, Forest Service, U. S. Department of Agriculture, 102 Motors Ave., Upper Darby, Pa.

Grafting Slash Pine in the Field and in the Greenhouse[1]

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This experiment was designed to develop a suitable grafting technique for slash pine (Pinus elliottii *Engelm.*) *as part of the forest genetics program. The techniques developed will be used in future breeding work to estimate the genotype of selected "plus" trees, to propagate selected trees and to establish seed orchards from superior parent stock. Various types and modifications of standard horticultural grafting methods have been tried with conifer forest species. It appears that special techniques have to be developed for the various species occurring in different climatic regions. A method which is successful in one climatic area may prove a complete failure in a region having different weather conditions. Such factors as time of grafting, age of stock, type of graft, and environment are extremely important if a large number of successful grafts are to be obtained. This study seeks to answer two questions. Is it physiologically feasible to graft slash pine scions? And which techniques are most efficient under north Florida conditions?*

Grafts of conifers do not form a union as quickly as most deciduous species and therefore scions are dependent upon stored products for a longer period of time. Yerkes (*15*) considered some type of glass-covered enclosure or sweatbox inside a greenhouse as necessary to provide a proper environment for conifer grafts to form a union. He recommended a night temperature of about 60° F. in the grafting case, and warned against wide temperature fluctuations during the early weeks after grafting. Hitt (*4*) recommended that the temperature in the graft beds should not go above 66° to 70° F. during the first 3 weeks after grafting. He stated "one day of high temperatures (above 80° to 85° F.) in the graft beds during the first 3 weeks after grafting is sufficient to so weaken or injure the material that death may follow."

The turgidity of a scion can be preserved either by placing it in a saturated atmosphere or by supplying water to the needles through the base of the scion as in bottle grafting. Placing the grafts in a sweatbox or under a bell jar helps to cut down the transpiration, whereas the bottle graft method keeps the scion material alive for a longer period by replacing the water lost in transpiration. The bottle-graft method is widely used in aspen breeding, as freshly-grafted scions can be used in controlled crosses (*4*). Water loss is also decreased by maintaining a relatively low temperature and restricting the wind movement.

Mirov (*7*) propagated desirable old specimens of ponderosa pine by grafting the young shoots on ponderosa and Jeffrey pine transplants. He trimmed the scion to fit a V-shaped cut in the stock. After the union was tied with a rubber band and protected with grafting wax, the grafted plant was kept under a bell jar for about 1 month. The bell jar helped to maintain a high relative humidity around the plant and slowed down the transpiration of the scion. Riker, *et al.* (*10*) grafted selected white pine scions on 4-year-old potted root stocks which had been forced for several weeks under artificial light in the greenhouse. After the scions were attached as veneer grafts, they were placed in an almost saturated atmosphere at about 70° F. for several weeks until a union was established. Bingham, *et al.* (*3*) held their veneer grafts of western white pine in the moist atmosphere of a sweatbox at a temperature of 65° — 70° F. until graft unions were secured, while bottle grafts were successful on the open bench in a greenhouse maintained at 65° — 70° F. Zak (*16*) covered his cleft grafts of shortleaf pine with individual humidity chambers to prevent desiccation of the plants. Other devices to reduce transpiration such as protecting the grafts with a plastic bag, or treatment of the scion with a latex dip, have been used successfully (*5, 10*).

The type of graft which is to be used depends on the species, size of material employed, and the environment. Stefansson (*13*), grafting pine and spruce in the field, found veneer grafts most satisfactory. The side slit method was suitable for small scion material and cleft grafting was used when only very strong stock plants were available. He also stressed the importance of careful shading during hot weather. Andersson and Jansson (*1*) reported good results for grafting conifers in the open when side-splice and side-slit grafts were used. The choice of the method depended upon the relative diameter of the scion and stock.

Effect of season is quite pronounced in both field and greenhouse grafting. Vogel (*14*) found in his grafting experiments with spruce, conducted from July 28 to September 8, that the percentage of successful grafts was greater during the later dates of grafting, although callus formation was less strong after the end of August. Dutch tree breeders (*2*) reported that under double glass the grafts of Scots pine on mountain and Corsican pine were 66 percent and 75 percent successful when grafted between September 9 and October 12, whereas grafting in late January and early February was 100

[1]This article is based on part of a dissertation entitled "Rooting and grafting of slash pine (*Pinus elliotti* Engelm.) for application in forest tree genetics" submitted to the Graduate School of Yale University in partial fulfillment of the requirements for the degree of Doctor of Philosophy. The author wishes to express his thanks to Mr. T. E. Evans for advice on statistical methods.

[2]When this article was prepared the author was attached to the Lake City, Fla., Research Ctr., Southeastern Forest Expt. Sta., U. S. Dept. Agric.

percent successful on both stocks used. Grafts in the open during September and October failed completely but those grafted in April gave 25 percent success.

Failures in grafting are often due to the fact that the scion starts to draw water before a union is formed. Best results are obtained when dormant scions are grafted on stock which is in an active state. Stefansson (*13*) collected his scions for summer field grafting between January and April and kept them in a fresh but dormant condition by packing the material in ice or moss at a temperature between—5° and —15° C. When grafting on potted stock, this difficulty can be minimized by bringing the plants into a warm greenhouse and forcing the stock into a more active stage by the use of bottom heat. As soon as root growth has started, as shown by the white root tips, grafting may begin (*6*).

First grafting attempts at Lake City, Florida, with slash and longleaf pine were made on 3-year-old rootstocks during 1942. Side grafts with tongue, cleft grafts, and needle bundle grafts were used (*8*). These first studies were on a limited scale and none of the grafts was successful. Schopmeyer (*12*), commenting on these first grafting attempts, mentioned that a satisfactory technique might be found if a well planned experiment with several kinds of grafts and stages of growth under several different environments could be carried out. A later study was also unsuccessful for lack of a satisfactory technique (*9*).

Under field conditions it is desirable to coat the union with a grafting wax to prevent desiccation of the cut surfaces (*4*). Andersson and Jansson (*1*) compared waxed and unwaxed field grafts of pine. Sixty percent of the grafts on natural regeneration, which had been waxed immediately after grafting, were successful, as against 21 percent for unwaxed grafts. If the rubbers are protected with wax they have to be kept under close surveillance to insure against binding.

Experimental Procedure

A total of 240 slash pine scions were grafted on slash pine stock using three types of grafts, under four different environmental conditions. The three types of grafts used were:

1. Cleft graft
2. Veneer or side-slit graft
3. Bottle graft

The grafted pines were kept under the following four environmental conditions:

1. Greenhouse—open bench
2. Greenhouse—sweatbox
3. Field—partial overhead shade
4. Field — partial overhead shade, covered by individual humidity chamber.

Four levels of modifying the scion environment were chosen to find the most satisfactory environment for grafting slash pine scions. The humidity chambers were used to reduce the diffusion pressure deficit at the callus zone. Outdoor conditions were included to determine whether or not grafting directly on stock in the field is feasible under the climatic conditions prevailing in north Florida.

Grafting Techniques

The three types of grafts were chosen because they have been found satisfactory by nursery men and tree breeders in grafting various species of conifers. All the grafts were tied with standard grafting rubbers and wrapped with friction grafting tape. After the union was tied it was coated with grafting wax to reduce desiccation and fungal infection. The grafting rubbers were removed during the early part of May to prevent strangulation of the union. A loose binding was placed over the unions to protect the grafts from breakage by wind.

In cleft grafting, the stock plant was severed several inches above the ground line. The top of the basal portion was then split with a sharp grafting knife. This vertical cut was extended downward for 1¼ inches by a rocking motion of the knife to prevent the stock from splitting. The lower 1½ inches of the scion was cut in the form of a wedge with a drawing motion and was forced into the cleft of the stock. The two were fitted together so that the cambium layers of the stock and scion were in good alignment. In the cases where the stock was larger than the scion, the scion was moved to one side so that the cambium layers came into contact. A completed cleft graft is illustrated in Figure 1-A.

The side or veneer graft was made by cutting a piece of the stock and shaping the scion to fit the wound. The downward cut was made 2 inches long on the plant which was to serve as the understock and inward for not over a third of the diameter of the stock. The piece of wood and bark was removed by a diagonal cut starting ½ inch from the base of the first cut. This left a small lip on the stock and helped to align and hold the scion. The scion was cut to fit this V-shaped basal notch. When there was a difference in size, the cambium of the stock and scion was aligned accurately on one side. Figure 1-B is a completed side-slit graft.

In bottle grafting, long cuts up to 3 inches in length were made in the stock plant and in the scion. They were tied firmly together as in any approach graft. The base of the scion was left intact and was inserted in a vial containing water. Several drops of a weak ferbam suspension were added to each vial to reduce fungal infection. Water was supplied to the scion through the submerged end during the period when the union was knitting. The vial was tied to the stock plant with friction tape (Fig. 1-C and Fig. 8).

After the side and bottle grafts were 3 weeks old, the remainder of the stock branches above the union were removed gradually. The speed of removal of this excess foliage depended somewhat upon the condition of the individual graft and the size of the stock, but in most instances was completed 12 weeks after grafting. The surface of the final cut was covered with grafting wax to prevent drying out of the stock.

Root Stock

Grafting under glass was done on potted stock, whereas in field grafting wildling slash pine stock was used. The term "stock" refers to the tree upon which the graft is made.

During July, 1952, 2- to 3-year-old slash pine seedlings were dug up with a "Council" transplanter and planted in 9-inch clay pots. The pots were watered monthly with 1 pint of a 2-percent solution of 7-6-19 soluble fertilizer to further root and top development. When the potted seedlings were moved into the greenhouse on January 14, 1953 they were in an excellent growing condition. For the field grafting, healthy 2- to 3-year-old slash pines, growing on a good site, were selected.

Scion Material

The term "scion" refers to the twig which is grafted on the stock for propagation.

The scion material was collected on January 27, the first day on which grafting in the greenhouse was started. It was taken from 10 vigorously growing slash pine trees picked at random in the 20- to 30-year age group. Collection was made from the branches at the outer edge of the upper half of the crowns, and only the distal ends of the primary branches were used for scions. The scions were cut to the necessary size just before grafting; the length depending on the type of graft. Only the previous year's growth was used. The lower part was stripped clean of the needles before grafting.

The scions which remained for the field grafting were stored in a refrigerator until they were used during the middle of February. Holding back the development of the scion is important when the growth of the stock cannot be controlled.

Greenhouse Grafting

After the potted slash pines were moved into the greenhouse they were fertilized and the soil in the pots was soaked with water. The temperature in the greenhouse was raised gradually over a period of 2 weeks to bring the slash pines out of the dormant stage. A bottom heat of 82° F. was supplied to the pots, and when grafting started on January 27 the root activity of the seedlings was well advanced.

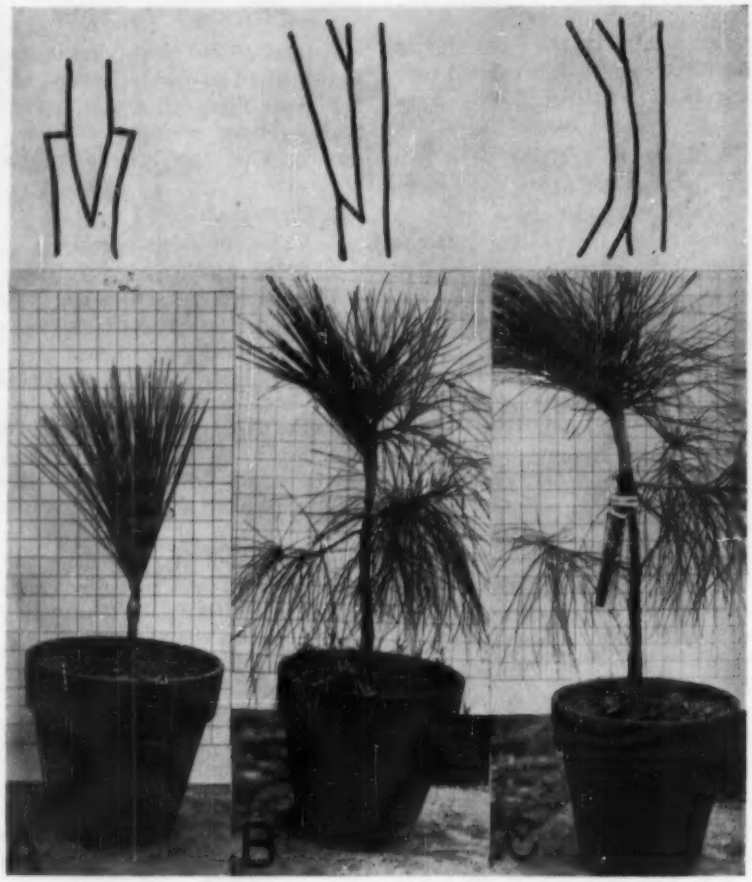

FIG. 1.—The three types of grafts used on 2- to 3-year-old slash pine stock. The lines of the grid are spaced at 1-inch intervals. *A*. Completed cleft graft. The scion is placed into a cleft made into the stock plant. *B*. Side slit or veneer graft. The scion is held in place by binding the union with a grafting rubber which is covered by grafting tape and grafting wax. *C*. Bottle graft. In this modified approach graft the base of the scion is placed in a vial filled with water. The vial is tied to the stock with friction tape.

As soon as a graft was completed, the pot was plunged in the beds and covered with a moist peat-sawdust mulch. All the spaces between pots were filled with mulch to keep the root systems moist. One-half of the grafts were kept under closed sweatbox conditions for a period of 10 days, while the other half were kept in the open bench. Cello-glass-covered sweatboxes were built to hold the plants in a moist atmosphere (Fig. 2). Efforts were made to keep the temperature in the closed beds below 70° F. during the first 3 weeks by whitewashing the glass of the greenhouse and by sprinkling water on the walls of the boxes. A hygrothermograph was placed in one of the two sweatboxes to obtain a permanent record of the temperature and humidity around the grafts.

After 10 days in the closed sweatboxes, the lids were opened gradually for airing and a fine mist of water was sprayed over the foliage. At first the lids were opened for a 10-minute period; subsequent airings depended upon temperature in the greenhouse. The lids were taken off completely after 5 weeks. The trees in the pots in the open benches were kept moist by operating the mist sprayers for ½ hour during the hot part of each day. The grafts in the closed frame were

FIG. 2.—Arrangement of grafts in greenhouse. Grafts on the left-hand side were kept under open bench conditions. Several of the grafts are visible through the celloglass cover of a sweatbox (right-hand side). The overhead sprinkler system was in operation for a short period during the hot part of the day.

placed on the same watering schedule after the lids were removed. Bottom heat was maintained throughout the experiment by thermostatically controlled heating cables.

Field Grafting

During the period of February 16-20, 1953, the scions which had been kept in cold storage were grafted on the wildling stock. The soil was moist and the temperature had been favorable for the start of root activities. The completed grafts were well watered and one-half of the grafts were covered with individual humidity chambers, constructed of black roofing paper. A 4-inch layer of wet peat-sawdust mulch was placed around the base of the stock, covering an area with a 10-inch radius. The tar-paper cylinder was held upright by stapling it to a stake driven into the ground. The top was covered with a glass pane to seal the moisture around the plants (Fig. 3).

The humidity chambers remained closed for the first 10 days, after which time they were opened for a short period each day. Pine straw was placed on each glass pane to shade the grafts and keep the temperatures from rising too high. The glass panes were removed 5 weeks after the start of the field grafting.

Both the covered and uncovered grafts were watered during the first 4 months after grafting whenever the upper layer of soil appeared dry.

A hygrothermograph was placed in a humidity chamber to obtain a permanent record of relative humidity and temperature surrounding the grafts during the period in the closed boxes. Thermometers inserted through the walls of several of the humidity chambers were helpful in checking the current temperatures within the chambers.

FIG. 3.—General view of part of the grafting plot in the second-growth slash pine stand. The grafts in the foreground are bottle grafts which were established under open conditions. Two sizes of sweatboxes were built to cover the grafts. The humidity chambers over the bottle and veneer grafts were 36 inches high while those covering the cleft grafts were 18 inches.

TABLE 1.—ANALYSIS OF VARIANCE OF SUCCESSFUL SLASH PINE GRAFT UNIONS. ALL DATA WERE TRANSFORMED, $\text{SIN}^{-1}\sqrt{\frac{X}{N+1}} + \text{SIN}^{-1}\sqrt{\frac{(X+1)}{N+1}}$ BASIS

Source of variance	Degrees of freedom	Mean square
Location	1	893.041 N.S.
Error (1)	2	154.074
Cover	1	12.042 N.S.
Location X cover	1	285.659 N.S.
Error (2)	2	83.184
Graft	2	8,477.927***
Graft X location	2	3,116.534**
Graft X cover	2	5,594.446***
Graft X location X cover	2	245.806 N.S.
Error (3)	8	221.709

**Exceeds mean square error, 1% level of significance.

***Exceeds mean square error, 0.1% level of significance.

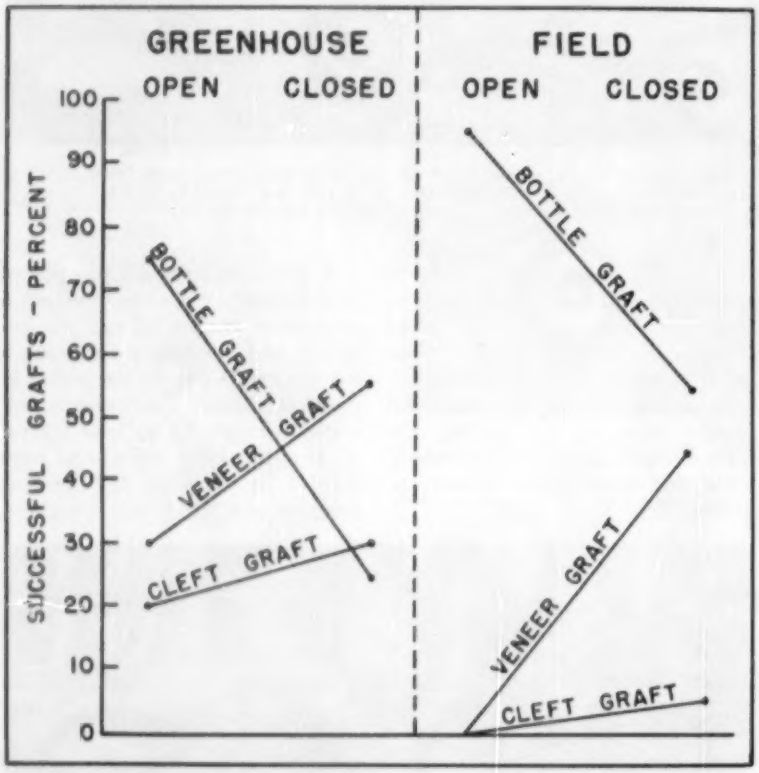

FIG. 4.—Graphical representation of successful graft unions. The average results for the three types of grafts are plotted against the environmental condition under which the grafts were kept. When veneer and cleft grafts were kept under sweatbox conditions a greater number of successful unions were obtained, whereas the closed humidity chambers had a depressing effect on the bottle grafts in both the greenhouse and in the field.

Statistical Design

A randomized block design was used having 2 blocks each with 10 individuals per treatment. The test was split between 2 locations and between 2 conditions within a block.

Results

The relative humidity in the closed sweatbox in the greenhouse, as measured with a recording hygrometer, remained very even during the 2-week period. At the start it rose to 99 percent but had dropped to 90 percent after the first 2 hours. The humidity remained close to 90 percent during most of the 2-week period while the sweatbox was closed.

The plan called for maintaining an air temperature below 70° F. during the first 2 weeks. However, all efforts failed to cool the atmosphere to the desired temperature in the greenhouse. The average night temperature was 68° F. but during the early part of the afternoon temperatures up to 85° F. were recorded.

The humidity within the sweatbox in the field remained around 99 percent during the first 6 days but dropped to about 95 percent for the remainder of the "closed" period. The temperature fluctuated considerably. The lowest night temperature recorded was 41° F., while afternoon temperatures occasionally rose to 100° F. Instantaneous readings with glass thermometers gave temperature readings of the atmosphere in several of the humidity chambers of up to 114° F.

Temperatures in the sweatboxes in the field and greenhouse were always higher than the temperatures of the surrounding atmosphere during the sunny part of the afternoon.

The transformed data for the number of successful unions 8 months after grafting were subjected to the analysis of variance, the results of which are presented in Table 1. In Figure 4 the average results are shown for both the field and greenhouse grafting.

There was no significant difference between the total number of successful grafts in the greenhouse and in the field. The average percent success for all treatments in the greenhouse was 39, while 33 percent of the grafts in the field were successful.

The total number of successful unions for grafts under the sweatbox condition was not significantly greater than for grafts in the open. The average percentage of unions under the sweatboxes was 37 percent, and the average for grafts in the open was 36 percent.

The type of graft, however, had a highly significant effect. Bottle grafts yielded the highest number of successful unions, namely 62 percent, while only 14 percent of the cleft grafts were successful. Only 32 percent of the side-slit grafts succeeded.

The interaction between type of graft and location was highly significant and the effect was most pronounced for cleft and veneer grafts. The average percentage for these two methods was 34 in the greenhouse, while only 12 percent of the cleft and veneer grafts were successful under field conditions. Bottle grafts gave better results in the field, (75 percent) than in the greenhouse (50 percent).

There was a highly significant interaction between type of graft and cover. As can be seen from Figure 4, the sweatbox had a beneficial effect on the cleft and side-slit grafts under both greenhouse and field condition, while the covers had a depressing influence in both locations on the bottle grafts.

The best success was obtained with bottle grafts on wildling stock in the field under open conditions, where 95 percent of the unions were successful. For the greenhouse grafting, bottle grafts under open bench conditions yielded the highest results; 75 percent of the bottle grafts had formed unions after a 3-month period.

Discussion and Conclusions

The results of this study prove without any doubt that slash pine scions from mature trees can be grafted successfully under various conditions. Several fundamental facts which were observed during this study should be of great help in devising satisfactory techniques to graft other conifers. One of the important points is the effect of water relations during the initial critical period.

Under open field conditions, where the relative humidity was comparatively low, the only successful unions were obtained with bottle grafts. Veneer and cleft grafts failed completely and most scions had dried out and died after 10 days. The stock was unable to supply the necessary amount of water to the scion. Water lost by transpiration could not be replaced as the contact layer between stock and scion impeded the movement of water between the symbionts. The meristematic tissue along the cut surfaces became dried out and no bridging callus tissue could be formed. However, when the veneer or cleft grafts were placed in an atmosphere with a high relative humidity, successful grafts were obtained. This would indicate that transpiration was reduced to the point where it did not desiccate the tissue and allowed the scion and stock to form a union.

Placing both veneer and cleft grafts under sweatbox conditions increased their successful unions, while bottle grafts kept under these conditions had a smaller number of successful unions. This fact brings out the importance of temperature on the knitting of a union. The average temperature in the sweatboxes in the greenhouse and in the field was always considerably higher than under open conditions. This higher temperature was not depressing enough to completely offset the beneficial effect of the high humidity for the cleft and veneer grafts, but it had a significantly depressing action on the bottle grafts which were not dependent upon high humidities. The success of the cleft and bottle grafts under sweatbox conditions would probably have been greater if the temperature had remained at a lower level. The buds of the scions under the sweatbox started to elongate within 2 days, and after 1 week up to 1 inch of growth had been added. This newly formed tissue was easily invaded by fungi and bacteria which were detrimental to the scion and fungal hyphae became very pronounced on some of the rapidly growing scions.

Cleft grafts gave the lowest number of successful unions. Pines in general do not develop root pressures under normal conditions, and this fact appears to be one of the main reasons for the low number of successful cleft graft unions. As no vascular connections are established for several weeks after grafting, the suction force provided by evaporation from the needles is not adequate to pull water from the roots into the upper parts of the plant. In most instances the root tips had turned brown within 2 weeks after the tops were cut off. The only successful cleft grafts were obtained with plants where either a small living limb was below the cut surface or where an epicormic branch formed on the remaining stub shortly after grafting. Evidently some green foliage is required to act as a pump in supplying water and nutrients from the roots of the stock to the scion. This would indicate that in order to obtain successful cleft grafts in slash pine a branch should be left on the stock to keep the stock alive until vascular connections between the stock and scion have formed.

The bottle grafts in the field gave better results than those placed in the greenhouse. The condition of the stock and the environment probably account for this difference. Potted slash pines, even when in fairly large pots, do not appear as healthy as plants which have a larger space for their root development. Moving potted plants from one location to another brings about a sudden change in environment which probably is not without consequence. The bottle grafts in general developed the most satisfactory union.

Some bottles were left on the trees without cleaning for at least 70 days and no adverse bacterial or fungal growth was evident. Hitt (*4*) recommended that in bottle grafting poplar scions, the base of the scion which is placed in the water must be cut off, about one-quarter of an inch each 10 days and that "every 10 days the vial must be removed and washed clean of all dirt, bacterial growth, etc." This precaution against infection was not necessary with pine scions, possibly as a result of the beneficial effect of the ferbam powder which was added to the water.

Storing the scions in a refrigerator to retard growth was probably beneficial, as the grafts in the field were successful. This storage peri-

od held back the activity of the scion while the stock plants continued their normal development.

The main purpose of the study, namely to develop a suitable grafting technique for slash pine scions from mature trees, has been fulfilled. In future grafting studies a large number of successful grafts should be obtained by grafting on slash pines growing in 2- to 3-year-old plantations during the early or middle part of February. The bottle-graft method, although the most time-consuming method tried, should be used. Partial shade can be provided by placing a sack over a temporary post and slanting it to shade the scion during the hottest part of the day. The planted seedlings should be fertilized prior to grafting and liberated from any competing vegetation. Grafting directly onto stock in the field will save a great deal of preparatory work which is necessary for greenhouse grafting.

If, however, greenhouse grafting is desirable, the bottle grafting technique under open bench conditions should be used in a shaded greenhouse.

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Notes

Survivals and Heights of Various Grades of Red Spruce Transplant Stock

In the spring of 1943 unhealthy trees were noticed in groups throughout the (2-2) transplant beds of red spruce (*Picea rubens* Sarg.) at the U. S. Forest Service Nursery at Parsons, West Virginia. Isolations from the roots and stems of these trees did not yield any pathogenic fungi; hence it was decided that the trouble was related to localized unfavorable soil conditions in the nursery.

In the usual U. S. Forest Service grading practice, all abnormal planting stock would have been discarded, and only healthy trees would have been retained for field planting. However, for the purpose of this experiment to gain information on the relation of planting-stock quality of red spruce to survival and height growth, the nursery trees were graded (Fig. 1) into five condition classes of 100 trees each, as follows:

Class A.—Healthy, with large dark-green crown and exceptionally good root development.

Class B.—Healthy, with good crown and average root development.

Class C.—Slightly diseased, with trace of chlorosis in crown and below-average root development.

Class D.—Moderately diseased, with considerable chlorosis in crowns and poor root development.

Class E.—Severely diseased, with severe chlorosis in crown and dwarfing of both crown and roots.

In April 1943 the 500 trees were outplanted at an elevation of 3,600 feet on a cool, rich, ½-acre site on the Monongahela National Forest, near Backbone Mountain Fire Tower in Tucker County, West Virginia. The trees were planted in randomized blocks of 20 trees for each class. The plantation was examined annually from 1944 to 1948, and again in 1954, at which time survival and height measurements were recorded (Table 1).

FIG. 1.—Examples of the grades of planting stock tested. Left to right, grades *A*, *B*, *D*, and *E*.

Total survival 11 years after the plantation was established varied from 69 percent for the better stock to 30 percent for the poorer stock. During the same period, average heights of the residual trees varied from 5.6 feet for class *D* trees to 7.9 feet for class *A* trees.

In classes *C*, *D*, and *E* there was significantly lower survival than for classes *A* and *B*. Classes *D* and *E* showed significantly lower survival than class *C*. There was no survival difference between classes *D* and *E*. Although mortality for all classes was heaviest during the first growing season, it continued at a fairly uniform rate for each class.

An analysis of variance of the differences in height growth during the 11-year period showed a significant difference at the 5-percent level between classes *A* and *B* and classes *D* and *E*. Differences in height growth between class *C* and all other classes were not significant.

The results of this study indicate the importance of healthy planting stock as a factor in subsequent survival and height growth of red spruce in plantations.

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TABLE 1.—SURVIVAL AND HEIGHT GROWTH FOR FIVE GRADES OF 2-2 RED SPRUCE SEEDLINGS, 1943 TO 1954

Year of examination	Survival by grade					Average height, by grade				
	A	B	C	D	E	A	B	C	D	E
	Percent					*Feet*				
1943	92	87	77	60	65	0.95	0.6	0.7	0.6	0.45
1944	91	85	75	58	64	1.0	.7	.8	.7	.55
1945	90	81	66	48	51	1.2	.95	.9	.8	.7
1946	90	81	66	45	51	1.6	1.25	1.25	1.15	.9
1947	90	81	65	44	51	1.8	1.4	1.5	1.2	1.05
1948	86	81	61	42	51	2.65	2.25	2.1	1.9	1.8
1954	67	69	50	30	32	7.95	7.7	6.7	5.6	5.9

Response of Black Locust to Phosphate Fertilizer[1]

Thousands of acres in Oklahoma have been planted to black locust (*Robinia pseudoacacia,* L). The plantings were made chiefly for the control of erosion and for fence post production. Many of these plantings have failed, due to site deficiencies (as might be expected where badly eroded land is planted) and attacks by the locust borer (*Cyllene robiniae,* Forst.).

The purpose of this study was to determine if superphospate (Calcium metaphosphate, $Ca(PO_3)^2$ applied to an established stand already showing signs of stagnation will restore vigor, increase the growth rate, and lessen the damaging effect of the locust borer.

A review of the literature on fertilization of forest tree species indicates that while the effects of fertilizers of various kinds are unpredictable and largely disappointing, the application of phosphate to seedling black locust showed striking results in increasing the rate of diameter and height growth and total weight of the plants.

The black locust plantation selected for the study is located in east central Oklahoma, in a 45-inch rainfall belt, on level upland agricultural soil very low in available phosphorus (0 to 2 parts per million). Clay content varied from 0 to 24.4 percent, sand from 33.6 percent to 47.6 percent, silt from 37.4 percent to 52.4 percent.

The fertilizer was applied at the rate of 150 pounds and 250 pounds of phosphorous (P_2O_5) per acre, and was evenly broadcast, without soil disturbance, on the surface.

In studying results of the experiment, chief reliance was placed on (1) the differential rate of diameter increase, (2) progress of differentiation into crown classes, and (3) fluctuations in the borer infestation.

During the first two years following the application of the fertilizer, the diameter growth apparently was stimulated somewhat in the fertilized plots. The effect was greater in the first than in the second year, and greater at the 150 pound level than at the 250 pound level. Five years after application, there was no significant difference between fertilized plots and check plots as regards diameter increase.

In an effort to discover whether the addition of more phosphate would have an effect, one plot was refertilized at the 150-pound level, and one check plot received a treatment at the 150-pound level. At the terminal examination, one year later, no effect of these applications was discernible.

The study likewise showed no significant relationship between fertilization and thrift, mortality, or stand differentiation.

The marked decline in the borer infestation which occurred over the five-year period of study was observed on the check plots as well as the fertilized plots.

In view of the results obtained, it is necessary to conclude that under the specific conditions of this study, the use of superphosphate on black locust cannot be recommended as an economically desirable practice.

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[1]Abstract of Research Project #629 bearing the same title, Oklahoma Agricultural Experiment Station, 1954.

Bitterlich's "Spiegelrelaskop"—a Revolutionary General-use Forest Instrument

The plotless method of determining basal area, whether crudely applied by use of the thumb width or a penny or more carefully done with a precise angle or wedge, has been tested and accepted as a valuable addition to the technique of cruising; so, when Harald Sutter, an Austrian graduate student, brought with him the German instrument invented by Dr. Bitterlich of Austria, the discoverer of the Angle Method[1] of plotless cruising, which utilizes the method and provided for many other field uses in addition, it was worth checking. The checks revealed that the initial doubts of the plumb-bob principle, upon which the instrument is constructed, were removed by its ingenious application and its use made possible the wide variety of measurements that had been incorporated. The instrument had Hoppus scales for British use which were not particularly useful in U.S., so a topographic scale for chaining and height measurements was suggested. The original use of a 2 foot horizontal stick attached to a tree as a range finder for an odd distance was not considered valuable, so Bitterlich in his American model of the "Spiegelrelaskop" invented a completely new range finder based on the chain as a unit of distance.

[1]Bitterlich, W. "Die Winkelzahlprobe" Allgemaine Forst-und Holzwirtschaftliche Zeitung, Volume 59 (1/2): 4-5. 1948.

FIG. 1.—The Spiegelrelaskop showing its compact size.

Bitterlich's "Spiegelrelaskop" (Figure 1) is an instrument that measures a tree's diameter directly to any height that stem visibility permits, estimates basal area by Bitterlich's Angle Method with effect of slope automatically corrected (it includes a choice of angles for stands of different average diameter and density), establishes distances of one or one and a half chains without a tape for any slope through its fixed distance range finder, measures heights, and reads slope on percent, degree, and topographic scales (Scales P, D, T, of

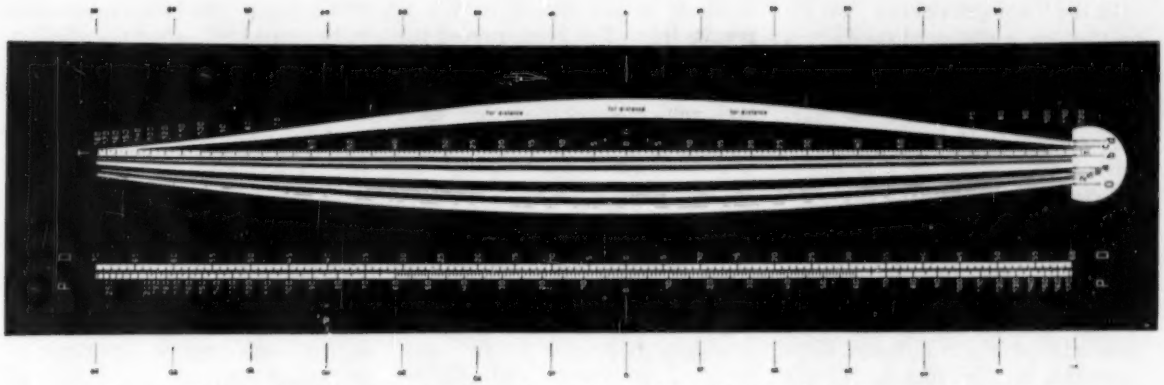

FIG. 2.—Illustrates the scales unwrapped from the pendulum wheel with the code to the scales at the base.

Figure 2). It is a ruggedly constructed, compact, light, hand instrument with a single moving part (not including the brake). The base is provided with a tripod socket for use where precise measurements are required.

The moving part of the instrument is a weighted wheel, upon the surface of which the scales are printed. The instrument has a wide field, quick stabilization of the wheel which gives a steady reading not readily disturbed by the average hand tremor, plenty of light, a clear view of scales superimposed on the lower half of the view by means of prism, mirror and lens, and a line of sight of no thickness with the corresponding reduction in angular error.

Figure 2 illustrates the scales by which the Relaskop accomplishes its many purposes. It shows the scales unwrapped from the wheel and indicates the manner in which the readings either adjust for slope where slope is an interfering factor or measure the slope where slope or height is the desired factor. Any particular reading can be fixed for checking by setting the brake (releasing the brake button).

The usual instrument employing Bitterlich's principle has a factor of 10 which when multiplied by the number of trees counted from the plot center that intercept an angle greater than 104.8 minutes, gives the basal area in square feet per acre. If the number of trees counted are separated by species, the composition of the stand in terms of basal area of the individual species is obtainable. By determining factors for each site class, the basal area figures can be converted directly into volume by species. The method does not reduce the number of plots necessary to get a reliable estimate of density, but it does speed up the job of measurement as plot boundaries and distances are unnecessary. However, the use of an instrument limited to the single factor 10 has all the limitations of using an average value for any other variable population. Stands vary in density and in size of the trees between wide extremes. In a dense stand the factor 10 reaches so far out from the plot center that there is introduced the serious error of a wrong count whether a tree is lost in the confusion of numbers or is bypassed because unseen behind the stems of its neighbors. A larger angle, i.e., a larger factor, shortens the plot radius in a given stand, thus reducing the number of trees to be counted and the likelihood of a tree escaping observation. In the case of a scattered stand, the factor 10 fails to reach far enough to give a reasonable number of trees; so a smaller angle, i.e., smaller factor, reaches farther and samples a greater area. In the same manner, the accuracy or convenience of the estimator may be served when dealing with small or large trees by varying the size of the factor.

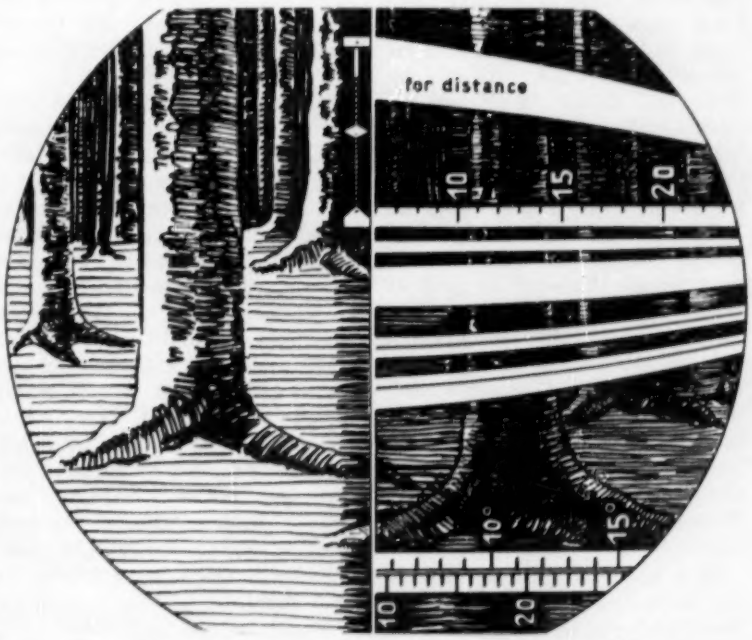

FIG. 3.—An enlargement of the code to the scales of the Relaskop.

In the "Spiegelrelaskop" the estimator has a choice of the factors 5, 10, 20, or 40 with no change necessary other than reading on a difference scale. In figure 2, the margin marked "0" is the common side of all angles; for a factor 5, all trees greater than the angle between "0" and the margin "5" are counted; for a factor 10 between "0" and "10"; for a factor 20 between "0" and "20" and for 40 between "0" and "a." The principle of the automatic slope correction is the reduction of the angle a tree must intercept in proportion as the slope steepens. A specific tree at a given horizontal distance from the observer should be counted if it intercepts an angle greater than the critical angle; if the same tree at the same horizontal distance is on the slope, then its slope distance distorts its relative size unless the critical angle is changed as the slope changes. Bitterlich's pendulum wheel turns as the line of sight moves up or down and reduces the critical angle so that all stands are read as though on a horizontal surface.

The distance between "a" and "b" in Figure 2 is equal to 24 inches at a horizontal distance of 66 feet (or 36 inches at 99 feet). The three white zones and three black zones (in the instrument the black and white zones are transparent as they are seen only by reflection) divide "a-b" into six parts—each the equivalent of 4 inches. Diameters may be estimated to the nearest inch at 66 feet. For use with trees greater than 24 inches in diameter the ingeniousness of the instrument becomes evident again. Between 24 and 48 inches (using 66 feet) the estimator should hold "10" on margin of tree and read 24 inches for the distance "10" to "a" plus the reading of the diameter scale. For trees between 48 and 72 inches, he should hold "0" on edge of tree and read 48 inches for "0" to "a." Trees of any diameter may be measured by varying the distance.

It is apparent from a study of the scales that the elimination of the slope factor in measuring d.b.h. permits the direct measurement of diameter at any height in a particular tree. The ingenuity of the instrument's construction, which permits all scales to be read simultaneously, becomes important when measuring diameters at particular heights on a tree. The height (Scale T) and diameter may be read simultaneously with no chance of losing the point of observation while changing from one instrument to another.

The Relaskop's range finder's simplicity is possible because it is designed to measure only the 66 foot and 99 foot *horizontal distance* from a tree regardless of slope. A six foot stick is held or leaned vertically against the tree and the observer takes a reading of the slope from the approximate distance and locks the wheel at that reading. The stick intercepts the distance between the margins "b" and "d" when the observer is precisely 66 feet distance. The instrument needs to be turned 90°, after the wheel is locked at the slope, and the stick measured parallel and at the line of sight. The distance between the margins "b" and "e" intercepts the six foot stick at a distance of 99 feet.

The ingenuity Dr. Bitterlich has shown in his design of the "Spiegelrelaskop" which enables it to reduce many complex problems of forest measurements to the turn of a wheel can only be described as revolutionary.

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Seedfall and Cutting Systems in Texas Shortleaf Stands

In the good seed year of 1951, a study in east Texas indicated important variations in seed production from shortleaf pine stands subjected to various types of reproduction cuttings. The study also yielded useful information on the pattern of seedfall.

When they were cut in the winter of 1949-50, the stands were about 55 years old and essentially even-aged. They contained from 6 to 15 M bd. ft. per acre, International ¼-inch rule. Three systems of cutting were used: single-tree selection, 30-tree shelterwood, and strip clearcutting. Cutting areas were from 12 to 15 acres in size; seed catch was not seriously affected by adjacent stands except for the strip cutting, where strips were 1.67 to 2.08 chains wide and seed was supplied by adjacent undisturbed timber. Seedfall was sampled in two stands cut by each of these three systems, eight quarter-milacre traps being located in each stand.

Beginning late in October 1951, the traps were examined at weekly intervals and the seed collected. Weekly collections were continued until seedfall abated at the end of January 1952. Thereafter, collections were made every two to three weeks until June, when seedfall became negligible.

Seed lots were kept separate and stored in a household refrigerator until germination tests were begun on March 21. Seeds collected after that date were placed directly in the germination dishes without the period of refrigeration. These tests were made in glass baking dishes with vermiculite as a medium. After 60 days the ungerminated seeds were cut to determine soundness.

Best Seed Fell First

The traps caught a total of 14,401 seeds from the 1951 seed crop. The heaviest fall occurred in November, when 59 percent of the total came down. One percent fell in October and 25 percent in December. By the end of March most of the remaining 15 percent had fallen. During the previous year the same traps in the same locations caught a total of only 34 seeds, but they fell in a similar pattern, most of them in November.

TABLE 1.—SEEDFALL RANGE PER TRAP AND AVERAGE PER ACRE BY STANDS, 1951-52

Silvicultural system	Stand number	Seeds per trap	Seeds per acre
		Number	*Thousands*
Strip clearcutting	B-4	65-102	330
	B-3	135-247	752
Single-tree selection	B-1	211-337	1,090
	B-2	239-316	1,150
30-tree shelterwood	B-9	317-400	1,436
	B-10	529-819	2,441

The periods of highest seedfall followed or coincided with sharp drops in temperature. Though often preceded by rain, such temperature drops in this area usually result from the advent of cold fronts, and are accompanied by low humidity and high winds from the north and west. These factors may be more important than either temperature or precipitation in determining the distribution of seedfall.

The seeds that fell late in the season had much lower germinability than those collected early. Gross germination declined from about 65 percent for collections made in the latter part of October to about 27 percent for those made in the early part of the following May. This decline was due mainly to the greater proportion of empty seeds found in later collections. While this fact is of small importance in nursery plantings where clean sound seed is used, it suggests early seedbed preparation to take advantage of more viable early seedfall for natural regeneration.

Germination of full seeds was also lower in lots collected later. Full seeds that fell in October showed a germination of 87 percent, while full May seed germinated about 71 percent.

Seedfall and Silvicultural System

Seedfall varied greatly on areas cut by similar systems. The installation was not sufficiently replicated to detect statistically significant differences between systems, but, as Table 1 shows, such differences might be large. Although cutting released seed-producing trees only 19 to 22 months prior to the maturity of the 1951 seed crop, this does not rule out the possibility that the different intensities of release were responsible for some of the differences in seed production.

Traps on clearcut strips registered the lowest seedfall, averaging 541,000 seeds per acre. These strips, of course, lack the parental overstory that remains on the selection and shelterwood areas: seed came only by lateral spread from the adjacent stands.

Both the selection and 30-tree shelterwood cuttings left seed-bearing overstories, beneath which the traps afforded a direct measure of seed production. The catch under the selection stand averaged 1,120,000 seeds per acre, while that under the shelterwood averaged nearly two million. Apparently the selection system either gave insufficient release to stimulate as much seed production as the shelterwood system, or else it resulted in cutting some of the best seed trees.

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Repeat Burns Reduce Small Stems in Texas Big Thicket

Prescribed spring burns repeated at short intervals can effectively reduce understory hardwoods in the Big Thicket type of southeast Texas. Surveys on 3- to 7-year-old demonstration burns show significantly fewer small shrub and hardwood stems as number of burns increase.

Of four pairs of 80-acre plots, one was burned once, in the spring of 1948; a second pair twice, in the spring of 1948 and 1951; a third three times, in the spring of 1948, 1951, and 1952. The fourth pair was unburned. Stands were typical of this flatwoods area. Loblolly pine was more abundant than shortleaf pine in the sparse pine-hardwood saw-timber overstory, beneath which small hardwoods, shrubs, and interlacing vines precluded pine regeneration. Commonest understory species are oaks, gums, yaupons, haws, arrowwood, candleberry, and huckleberry.

Prescribed burns were made when wind and fuel moisture permitted moderately complete and rapid spread, without excessive risk to the overstory stand. Damage to merchantable trees was negligible.

Stems in the 1-, 2-, and 3-inch stump diameter classes were counted on 24 systematically spaced milacres on each plot in November 1954. Results are shown in Table 1. The linear correlation between total number of 1-, 2-, and 3-inch stems (Y) and the number of fires (X) is highly significant and can be expressed in regression form as $Y = 2778 - 731X$

The indicated reduction of 731 stems for each additional fire treatment reflects both cumulative kill by reburning and increased reestablishment of small stems over the longer period since the first and second burns. Evidently repeated treatments will be needed to achieve and maintain substantially reduced understories in the Big Thicket type.

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TABLE 1.—NUMBERS OF SHRUB AND SMALL HARDWOOD STEMS PER ACRE.

Size class	0 burn	1 burn	2 burns	3 burns
1-inch	1,708	1,354	1,104	333
2-inch	708	354	271	104
3-inch	396	208	104	83
Total	2,812	1,916	1,479	520

Points of View

Some Comments on Fire Law Enforcement in the South

Henry Sipe's comments in the September issue of the JOURNAL[1] on the Lehman-Vogenberger article on TVA fire control activities[2] are challenging, timely, and pertinent. They come from a qualified and successful practitioner of the art of fire law enforcement and should not be dismissed casually. Certainly the apparent continued increase in number of forest fires is not something about which the forestry profession can be complacent. It seems to me, however, that we can afford to be somewhat philosophical about the law enforcement angle.

After almost thirty years of work in several parts of the United States—including five years of fairly intensive and reasonably successful fire law enforcement on the Eastern Shore of Maryland—I am convinced that the degree of law enforcement, whether fire law, traffic law, or any other one might mention, is usually a direct reflection of public understanding, interest, and support. There is a wide variation of support not only from state to state but frequently from county to county within a state and even by areas within a county. I am satisfied that the state foresters in the seven Tennessee Valley states, like state foresters elsewhere, are enforcing their state laws just as vigorously as public support will permit. Each year witnesses more attempts at law enforcement and a higher proportion of the attempts seem to be successful. The reception accorded to the courageous work of State Forester Mixon's organization as featured editorially in June 1955 *American Forests* is an example.

Reflection on Sipe's letter recalls to memory many incidents illustrating the realities of fire law enforcement. Such experiences are, of course, common to all foresters who have engaged in fire protection work, but relating a few of them will serve to emphasize the point I wish to make.

About five years ago, in as tactful a manner as possible, I tried to emphasize to one state forester the importance TVA attached to better fire control in a particular watershed area. He finally exploded about as follows: "Why, man, it has only been three years since we were able to prevent annual spring 'swingeing' of the state house lawn."

In the 1930's in one Maryland county, where railroad fires had been commonplace, we were finally successful, through rigid enforcement of a right-of-way clearance law, in practically eliminating fires from engines. I still recall vividly the public scolding I took from a landowner whose words were about like this: "I own an old farm out along the railroad. Until a few years ago, I regularly collected $2 an acre from the railroad from fires which burned over 100 to 200 acres or more each year. Claims were generally paid without question. This was a good source of income. I haven't collected a cent during the past three years since you fellows stopped the fires. I can't sell the farm. I wish I had never heard of your state forestry department."

A heart-warming contrast was provided in another county. This involved a state senator who had formerly been a state's attorney. He represented a man who had been flagrantly careless in permitting the escape of a fire which proved to be usually damaging. This lawyer, the other man's counsel, mind you, called me aside just as we were about to go to trial in JP Court and said essentially this: "If we go to trial, I will beat you on the criminal charge. I would prefer not to do this because I think what you fellows are trying to do in stopping these fires makes sense, and I am one hundred percent behind you. There is no question about the carelessness in this case. Why don't you permit settlement through payment of the suppression costs. If so, I believe I can assure you that this man will never start another fire."

In another case the state's attorney initially refused to prosecute four incendiarists where the evidence was complete and overwhelming. However, our local fire warden, who had substantial political standing and who became incensed at this attitude, threatened denial of support in the next campaign which was soon coming up. Successful prosecution followed in short order.

Here in east Tennessee, we have an interesting contrast between fire occurrence in the Great Smoky Mountains National Park and on adjacent privately owned lands. A small fire in the National Park usually makes the front pages in our daily newspapers and is regarded as something of a catastrophe. At the same time a several-hundred-acre fire on nearby private lands may get a couple of lines in an inconspicuous spot on an interior page. Recently, in two counties in the Cumberland Mountains where fire incidence has been unusually high, we, in cooperation with the state forester, made an intensive study in an attempt to learn why. We ascertained two significant facts:

1. Contrary to previous belief, most fires were not started by in-

[1] Sipe, Henry. Comments on "The role of a regional agency in fire control." Jour. Forestry 53:669-670. 1955.

[2] Lehman, J. W., and Ralph A. Vogenberger. The role of a regional agency in fire control. Jour. Forestry 53:430-435. 1955.

knee-high to a hardwood . . .

but watch conifers grow when overtopping hardwoods are controlled with

DOW BRUSH KILLERS

Dow brush killers offer a positive means of removing hardwood competition to speed the growth of seedling conifers. Pine seedlings and other high-value timber species mature in a surprisingly short time after chemical control of overtopping hardwoods gives them adequate room, air, sunlight, soil nutrients and moisture.

Dow has developed special-purpose silvicides—Esteron® 245 and Esteron Ten-Ten—to answer this problem. Application to hardwoods can be for the release of planted conifer seedlings or as a pre-planting treatment. Defoliation of hardwoods occurs soon after application and new terminal growth of conifers often doubles after an area is released. Esteron 245 gives year-around control of most hardwood species, including maple, and most brush species when used for foliage application, basal bark or frill treatment. Esteron 245 is the most versatile silvicide available today—it may be used in either air or ground application equipment. Esteron Ten-Ten is useful for control of aspen, hazel, alder and willow.

These specific-type silvicides give you an opportunity to regulate costs according to the type of vegetation that must be controlled.

We invite inquiries from state and federal foresters, lumber companies and tree farmers. Dow sales and technical men are available to help assist in this new chemical method of hardwood control. THE DOW CHEMICAL COMPANY, Agricultural Chemical Sales Department, Midland, Michigan.

you can depend on DOW AGRICULTURAL CHEMICALS DOW

cendiarists but rather by careless debris burners and hunters.

2. Over half the landowners where fire occurred were unconcerned.

A contrast was provided to this attitude by a forest landowning industrialist about two years ago in Mississippi who publicly threatened to discontinue all forestry programs and liquidate his operation unless an acute fire problem in his vicinity was corrected. As a result, forest protection received much supporting newspaper comment over a several-state area. This should help to make law enforcement more effective.

The point I am trying to make is that there is a wide range in attitude on the part of people who in aggregate actually determine whether laws are enforced. Much more than the law enforcement officer's skill and attitude is involved. Injured landowners, state's attorneys, judges, legislators, jurors, newspapers, and citizens generally must insist on law enforcement, or at least not place obstacles in the way, before an enforcement officer can do his job.

There are many signs that the public attitude so necessary for forest fire law enforcement is developing in an encouraging way throughout the South. While progress may at times appear to be slow, the ultimate goal of a fully informed and aroused citizenry is glimpsed more frequently. In the meantime, we also have statutes dealing with such problems as drunken driving, embezzlement, dog vaccination, murder, gambling, juvenile delinquency, fish and game, etc. I wonder whether our forest fire law enforcement record is relatively any worse nationally than with these or other kinds of human cussedness which continue to perplex organized society?

KENNETH J. SEIGWORTH, *Chief,*
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Division of Forestry Relations,
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Coming Events

Kentucky-Tennessee Section

The Kentucky-Tennessee Section will hold its annual meeting December 2-3, 1955 at Mammoth Cave, Ky.

National Watershed Congress

The National Watershed Congress will be held December 5-6, 1955 at the Statler Hotel, Washington, D. C.

46th Western Forestry Conference

The 46th Western Forestry Conference and annual meeting of the Western Forestry and Conservation Association will be held December 7-9, 1955 at Portland, Ore.

Allegheny Section Meeting

The winter meeting of the Allegheny Section will be held February 10-11, 1956 at the Bellevue-Stratford Hotel, Philadelphia, Pa. John R. McGuire, 816 Cedar Avenue, Drexel Hill, Pa. is in charge of local arrangements.

21st North American Wildlife Conference

The 21st North American Wildlife Conference will be held March 5-7, 1956 at the Jung Hotel, New Orleans, La.

TIP IT--
Even lay it flat-
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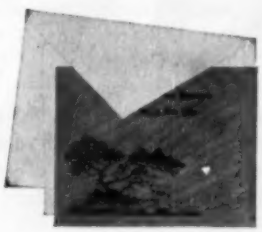

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Walter Mulford (1877-1955)

The death of Walter Mulford on September 7, 1955 at St. Helena, Calif., brings to a close an eminent career in professional forestry education. Forty-two of his 46 years of active service to forestry were spent in teaching and academic administration at California, Cornell, Michigan, and Yale.

Born in Milville, N. J., September 16, 1877, Walter Mulford graduated in agriculture at Cornell in 1899. Two years later he earned the degree of forest engineer from the same institution as a member of the first professional forestry classes in America.

His initial professional assignment was to establish the state forestry organization of Connecticut. There he was the first man in the United States to hold the title of state forester. Between 1904 and 1906 temporary assignments with the then Bureau of Forestry gave Mulford first hand contact with the U. S. Forest Service during the period of its dynamic growth. After brief periods as an assistant at the Yale School of Forestry, he was appointed as assistant professor of forestry at the University of Michigan in 1905—the first American-trained forestry teacher in the country.

Initially, Mulford was "the other half" of the Forestry Department at Ann Arbor under Filibert Roth. He remained there until 1911 when Liberty Hyde Bailey induced him to return to Cornell to rebuild forestry instruction which had been abandoned there eight years before. During the ensuing three years as professor and head of the Department, he not only restored professional forestry education to the Cornell campus but also planned and supervised the construction of Fernow Hall.

Shortly before the first World War, Mulford agreed to go to the University of California to establish a new forestry school there. He arrived in Berkeley in 1914 and resided there for the remainder of his life.

As professor and head of the Division of Forestry in the College of Agriculture, Mulford launched the California program that same year. In 1939 the Division of Forestry was designated a Department. The final goal was achieved in 1946 with the establishment of the University of California School of Forestry. Walter Mulford was, of course, its first dean. The present Forestry Building which he had long envisaged and planned as the physical embodiment of the School was completed two years later.

Apart from his talents as an organizer and builder of forestry education, Mulford had profound influence as a teacher of men. Early in his career he became convinced that the best training for professional strength lay in sound education in the basic sciences coupled with emphasis upon forestry principles. He was imbued with an unconquerable idealism, transparent sincerity, and complete faith in the high mission of forestry. He had rare capacity to communicate much of this philosophy and idealism to his students. These characteristics, added to his friendly and warm hearted personality, made Walter Mulford an inspiration, a challenge, and a beloved figure among the hundreds of men whom he taught.

Mulford's work as consulting editor of McGraw-Hill Book Company's *American Forestry Series* (1933-1950) represented a further major contribution to professional education. Under his leadership the *Series* grew to include 23 volumes covering most of the important areas of technical subject matter. The breadth of his forestry interests and concerns is also indicated by his service as vice president of the First World Forestry Congress held at Rome in 1928, and his appointment in 1942 as advisor to the National Bureau of Forestry Research of China.

He served on the Board of Editors of *The Forestry Quarterly*. He contributed many articles to it and to its successor the JOURNAL OF FORESTRY. These articles reflect his concern with forestry education, policy, and economics. For many years he was active in the affairs of the Society of American Foresters, as its president (1924) and in other capacities.

His early interest in state forestry was sustained throughout his life. He made important contributions to the development of strong state forest policies in California through participation in the work of its Board of Forestry and the Forest Policy Committee of its Chamber of Commerce.

He was a Fellow of the Society of American Foresters, an Honorary Member of the California State Board of Forestry, and a Fellow of the American Association for the Advancement of Science. In 1938 the University of Michigan awarded him the honorary degree Doctor of Science, citing his notable efforts in "quickening public interest in the value of forests as a factor in modern industry."

After his retirement from the University in 1947, he continued work for several years on editorial and writing interests. His passing brings to an end an eminent career which both encompassed the entire life of the forestry profession in America and did much to orient and inspire its growth. Walter Mulford's faith in forestry, his idealism and his high integrity remain as examples to which all in the profession may well aspire.

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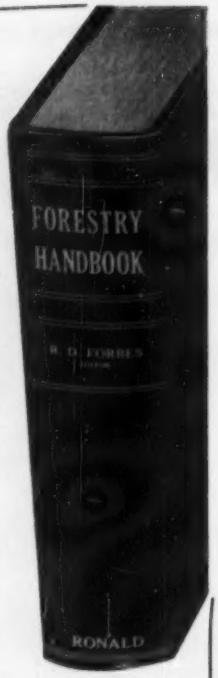

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Reviews

Wood Handbook

Prepared by the Forest Products Laboratory. 528 pp. Illus. Superintendent of Documents, Washington 25, D. C. 1955. $2.

An enlarged and revised edition of the U. S. Department of Agriculture's *Wood Handbook* has been issued by the Forest Products Laboratory, Madison, Wis.

Since the *Handbook* was first published in 1935, it has been recognized as an outstanding reference book on the properties and structural uses of wood. It is widely quoted in specifications, building codes, engineering and structural textbooks, and other publications as a basic authority.

During the past two decades new research findings, together with developments in the wood-using industries, have brought far-reaching changes. Since 1935, basic information about wood has been greatly broadened, new wood products have been developed, and advanced engineering principles applied to wood construction of all kinds. The new edition of the *Handbook* includes much basic information on these materials and processes.

The use of laminated wood in large structural members was still in its infancy when the first edition was published. Practically all of the work in sandwich construction, which combines wood and other materials, has been done since 1935, and many new uses have been found for plywood.

The present *Handbook* contains more than twice the number of pages of the original volume. It presents information on subjects that the 1935 version never even mentioned.

A new section on structural sandwich construction includes information on the fabrication and design of sandwich panels, as well as the results of extensive research on the insulation properties, fire resistance, and durability of sand-

wich construction.

A new section on plywood and other crossbanded products has been revised and enlarged. It features the results of much research on the strength and physical properties of plywood. The completely revised section on glued wood lamination contains the most recent information on the characteristics, design, and strength of laminated members.

The new section on building fiberboards covers various types of insulation board and structural hardboard. The new section on modified woods and paper base laminates includes most of the available information on these new products of wood research.

Over the past 35 years the Forest Products Laboratory has made innumerable contributions to the literature of wood technology. The *Wood Handbook* is one of the most popular and most useful.

❦❦❦

Tree Planting Practices for Arid Areas

By A. Y. Goor. 126 pp. Illus. Published by Food and Agriculture Organization of the United Nations. For sale by Columbia University Press, New York, N. Y. 1955. $1.50.

"There is no branch of forestry in which so much care must be taken of detail as planting in arid regions."

These words, from the volume under review, might well serve as the theme of the entire work. The author has himself gone into considerable detail in discussing parts of his subject and has brought together in one place many hitherto isolated facts about tree planting in the Near East. It is this portion of the arid areas of the world with which he is primarily concerned and the material he has gathered has particular application to the Near East. Undoubtedly, it has application to other arid areas.

Part 1 deals with the collection and handling of seed, and discusses basic practices from collection of seed of superior origin to pretreatment before sowing. Part 2, forest tree nurseries, contains a rather complete section on locating and laying out nursery beds. Part 3 is concerned with plant production in nurseries and covers the field thoroughly from the use of different types of containers through seed sowing, transplanting, and irrigation to final transportation of stock from the nursery. Part 4 covers the broad field of afforestation from site selection to care of established plantations.

Three appendices list the species used in afforestation in the Near East, and summaries of seed collection and handling practices and nursery operations. A list of selected references is included.

It is inevitable that in trying to cover such a broad field the treatment given to any one phase of the subject must be necessarily brief. For example, the section devoted to spacing of trees in plantations covers about two-thirds of a page. This extremely important topic deserves more attention and the effect of possible early thinnings

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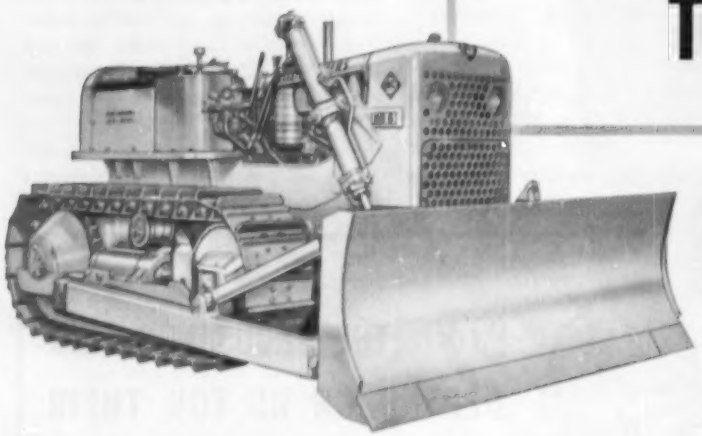

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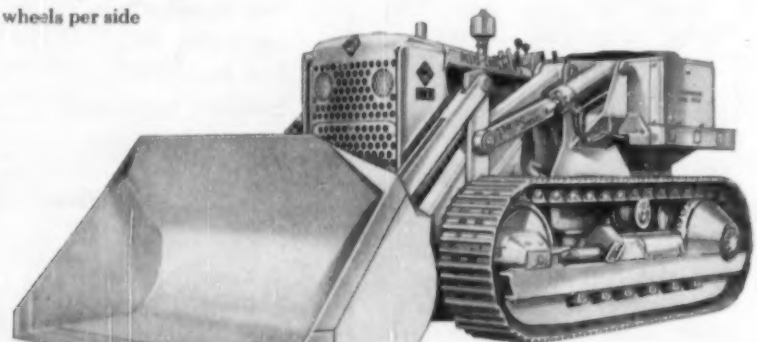

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to allow for closer initial spacing has been ignored. In the wood-hungry Near East this is an important matter.

A. Y. Goor is the Conservator of Forests in Israel. Because of this fact it was probably not possible for him to visit with or even correspond with foresters from the nearby Arab states and to gather information on new techniques which have been developed in recent months by them in cooperation with the foresters from the United States working for the former Technical Cooperation Administration, later Foreign Operations Administration, and now International Cooperation Administration. The use of soil augers in preparing holes for planting, for example, is one such technique which can have a great impact upon forest planting practices in the arid regions and is not mentioned.

In spite of these shortcomings the volume is an excellent handbook on planting in the Near East region, and should serve as an excellent guide for training purposes.

R. W. ABBOTT
Morristown, Tenn.

Cunningham and Reed's Guide to Earning a Living.

By Ed Cunningham and Leonard Reed. 116 pp. Simon and Schuster, New York, N. Y. 1955. $3.95.

Of the numerous vocational guidance books and brochures on the market—some of which are excellent and others of doubtful value—this is one of the best. It presents a brief survey of 119 careers in business, the professions, trade, agriculture, and government.

In addition to outlining the probable future of each career, the book indicates salaries to be expected, educational requirements, physical qualifications, duties and responsibilities, and the advantages and disadvantages of each job.

Forestry is one of the professional careers described.

The Forester's Companion

By N. D. G. James, 312 pp. Basil Blackwell, Oxford, England. 1955. 12s. 6d net.

For day to day work in the woods foresters require a reference book containing figures and other information which most of us have learned at one time or another but cannot carry with confidence in an overloaded memory. For British foresters this new book by N. D. G. James meets this need in an admirable manner. It contains a vast amount of detailed information, condensed as far as possible into tabular form and, although it is rather fat, it is not too large for the pocket.

Mr. James is land agent to Oxford University and his personal duties cover the wide field of land management. He has specialized in woodland management, but the fact that he is not primarily a forester is perhaps a qualification for writing a book of this kind, because those who have the wide obligations of a land agent are necessarily more dependent than pure foresters may be on such a source of information. Also he has the rare mental equipment which enables him to handle a vast array of facts and figures in a clear and methodical manner.

The book has been published in conjunction with the Royal Forestry Society of England and Wales, and it is appropriately introduced by a foreword by C. M. Floyd, the president of the Society. In view of the wide circulation which may be anticipated it has been produced at a very reasonable price.

To provide a picture of the general content of the book it would be necessary to list the titles of the 31 chapters. Suffice it to say

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Obviously, the Society cannot assume responsibility beyond making it possible for prospective employee and employer to enter into negotiations.

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Box B, Journal of Forestry, Washington 6, D. C.

Forester, 27, B.S.F. Univ. of Pa. State 1952, single, veteran. Presently employed with state agency. Desires relocation offering opportunity for advancement. Experience: 3 years formulating and carrying out timber management plans.
Box C, Journal of Forestry, Mills Building, Washington 6, D. C.

that it covers all the operations of silviculture from nursery work to diseases and pests; forest management from timber measuring, through roads to extraction, utilization, and timber preservation; the valuation and sale of timber; fencing and shelter belts; amenity planting and shooting; forest law and state assistance. The concluding chapters deal with the organization of the Forestry Commission, the ambit of forestry societies and teaching organizations, arboreta, forestry books, and periodicals.

Where practicable the information is expressed in the form of tables. But this is only possible with a small part of the subject matter and the bulk of the book is composed of numbered sections, subsections, and paragraphs. Many of these paragraphs are of one line only and indicate an objective, a method, or an item of information. The matter is so cleverly condensed that these paragraphs together provide a compendium of woodland activities.

There is a danger that this method of expression may crystallize in too hard a fashion the technique of forest management. It cannot allow sufficiently for the variety of forest needs, the individuality of foresters or, indeed, the progressive changes which should charaterize an active industry. This danger does not apply to those tables which are factual, such as the number of trees per acre required for various planting distances, to the present constitution of the Forestry Commission, or to current yield tables; and it is amusing to prepare a speculative list of those operations which are most likely to be influenced by technical changes in the foreseeable future.

This list would cover the whole field of mechanization, more particularly through improvements in nursery equipment. There is likely to be a broadening of planting distances, especially for fast growing species, and some of the distances given in Mr. James's list appear to be already out of date. Also, although thinning practice in

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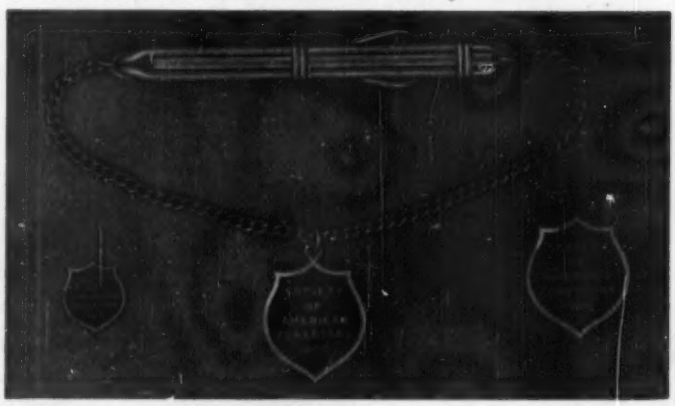

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Britain is much heavier than in continental Europe, it is likely to become heavier still. The use of seedlings in place of transplants for planting in the forest may become commoner; the only species for which Mr. James recommends them is oak.

Prices and costs fluctuate to such an extent that Mr. James wisely omits them. But for all other aspects of woodland practice the book is a very handy and reliable guide and foresters will be very grateful to the author for preparing it.

W. E. HILEY
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Totnes, South Devon, England

Trees and Shrubs of the Upper Midwest

By Carl O. Rosendahl. 411 pp. Illus. Univ. of Minnesota Press, Minneapolis 14, Minn. 1955. $6.

This book attempts—and achieves—that which is not often found in scientific publications. The author has presented detailed, correct, and up-to-date botanical information which should satisfy the needs of the professional botanist and, at the same time, has made the book clear, useful, and interesting for the amateur.

The result of almost a life time of intensive taxonomic study by Dr. Rosendahl, professor emeritus of botany, University of Minnesota, it is, in part, a modification and extension of the older work by Rosendahl and Butters, *Trees and Shrubs of Minnesota.*

By "the upper Midwest" the author refers to an area extending from Manitoba through Minnesota, most of Wisconsin, the eastern Dakotas, parts of Iowa, Illinois, and upper Michigan. Since a fairly wide north-south range and a variety of habitats occur within this area, undoubtedly the keys can also be used with profit in adjoining regions.

Botanists will find long needed revision of the genera Crataegus, Rubus, and Amelanchier. All three of these difficult genera have been completely re-worked and the species re-examined. Speciation appears to be much more clearly delineated. The new presentation of the genus Rubus is particularly noteworthy and will be extremely useful. Rosendahl departs from the standard nomenclature of Gray's *Manual* in several places. For example, he includes in the family Corylaceae plants which Gray's *Manual* places in the family Betulaceae, and he uses the term Sorbus in place of Pyrus for the genus of mountain ash.

Amateur naturalists will find much of interest in the plant descriptions, for the author has included information on the horticultural and industrial uses of the species, their distribution, and the derivations of plant names. The numbered keys are easy to use, their statements concise and definitive. There is a refreshing lack of the puzzling, overlapping choices so frequently found in botanical keys. The line drawings, many of them taken from the older volume, are very helpful, particularly in species determination of difficult groups. There is a useful glossary and index to both scientific and common names.

As a complete and amazingly usable manual for the identification and understanding of the woody species of the region, Rosendahl's new book should become a standard reference and will probably soon be found on the bookshelves of most foresters in the Midwest area.

CLIFFORD E. AHLGREN
Quetico-Superior Wilderness Research Center, Ely, Minn.

Publications of Interest

Directory of Forest Genetics Research and Education in the United States and Canada by Jonathan W. Wright has recently been issued by the Northeastern Forest Experiment Station, 102 Motors Avenue, Upper Darby, Pa. A publication of the Committee on Forest Tree Improvement of the Society of American Foresters' Division of Silviculture, it is the first directory of its kind in the rapidly developing field of forest tree improvement.

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Current Literature

Compiled by MARTHA MEELIG, *Librarian, State University of New York College of Forestry*
Range Management Section Compiled by FRANCIS FLICK, *Library, U. S. Department of Agriculture*

General

Biology of Deserts. B. J. W. Cloudsley-Thompson. 224 pp. Illus. Inst. of Biology, London. 1954. 14 s.

Brief Information on Forestry Situation in Thailand. By Sukhum Thirawat. 85 pp. Royal Forest Dept., Bangkok. 1955. Bul. No. B. 17. Mimeog.

Identification Keys to Genera and Species of the Dipterocarpaceae of Thailand. By T. Smitinand. 27 pp. Royal Forest Dept., Bangkok. 1954. Forest Bul. (Botany) No. 1. Mimeog.

The Song of the Pine Tree Forest. By Dorothy Marino. Picture book for ages 3-6. Lippincott, Philadelphia. Sept., 1955. $2.00.

Types of Forests of Thailand. 9 pp. Illus. Royal Forest Dept., Bangkok.

U. S. Forest Service. By C. B. Colby. Illus. Coward-McCann, New York. Sept., 1955. $1.25. Ages 8 up.

Forest Influences

Climate in Southeast Alaska in Relation to Tree Growth. By H. E. Andersen. 5 pp. Maps, tables. Alaska For. Research Center, Juneau. 1955. Station Paper No. 3. Mimeog.

Facts About Wind Erosion and Dust Storms on the Great Plains. By Soil Conservation Serv. 8 pp. Illus. U. S. Dept. of Agric., Washington 25, D. C. 1955. Leaflet No. 394. 10 cents (Govt. print. off.)

Influences of Reforestation and Erosion Control upon the Hydrology of the Pine Tree Branch Watershed 1941 to 1950. 95 pp. Illus. TVA, Hydraulic Data Branch, Knoxville, Tenn. 1955. Tech. Mon. No. 86. $1.50.

Land Use

The Cornell System of Economic Land Classification. By H. E. Conklin. 10 pp. Dept. of Agric. Economics, New York State College of Agric., Ithaca, N. Y. 1955. Mimeog.

Logging and Lumbering

Lumberman's Safety Association 39th Annual Meeting, Empire Hotel, North Bay, Ont. Apr. 19th, 1955. Report of Proceedings. 24 pp. 90 Harbour St., Toronto, Ont.

Pathology

Fire Scars and Decay in Missouri Oaks. By P. Y. Burns. 8 pp. Illus. Univ. of Missouri Agric. Expt. Sta., Columbia. 1955. Bul. No. 642.

Injury to Northwestern Forest Trees by Sulfur Dioxide from Smelters. By T. C. Scheffer and G. G. Hedgcock. 49 pp. Illus. U. S. Dept. of Agric., Wash-

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ington 25, D. C. 1955. Tech. Bul. No. 1117. 25 cents (Govt. print. off.)

Protection

The Black Turpentine Beetle, Its Habits and Control. By R. E. Lee and R. H. Smith. 14 pp. Illus. Southern Forest Exp. Sta., New Orleans 13, La. 1955. Occasional Paper No. 138. Mimeog.

Forest Pest Leaflet(s). U. S. Forest Serv., Washington 25, D. C. 1955. 4 pp. ea. 5 cents ea. (Govt. print. off.)
No. 1. *The Western Pine Beetle.* By F. P. Keen.
No. 2. *The Mountain Pine Beetle.* By G. R. Struble and P. C. Johnson.
No. 3. *The Saratoga Spittlebug.* By C. B. Eaton.
No. 4. *California Five-Spined Engraver Beetle.* By G. R. Struble.
No. 5. *Douglas-Fir Beetle.* By J. C. Evenden and K. H. Wright.

Lyctus Powder Post Beetle. By W. H. Bennett. 4 pp. Illus. Texas Forest Serv., College Station. 1955. Cir. No. 49.

Range Management

Area Ignition for Brush Burning. By R. L. Fenner and Others. 10 pp. Illus. U. S. Forest Serv. Calif. Forest & Range Expt. Sta., Berkeley. Tech. Paper No. 10. July 1955. Processed.

Eighteen-Year Summary of Range Improvement Studies, 1937-1954. 32 pp. Illus. Southern Great Plains Field Station, Woodward, Okla. 1955. Mimeog.

North American Prairie. Revised. By J. E. Weaver. 348 pp. Illus. Johnsen Pub. Co., Lincoln, Nebr. 1954. $5.00.

Stockmen's Handbook; Stockmen's Short Course, December, 1954. 180 pp. Washington State Col. Institute of Agric. Sci., Pullman. 1955.

Silviculture

Blight Resistant Chestnuts; Culture and Care. By Hans Nienstaedt and A. H. Graves. 18 pp. Illus. Connecticut Agric. Expt. Sta., New Haven. 1955. Cir. No. 192.

Epicormic Branching on Oaks in Sprout Stands. By K. A. Brinkman. 8 pp. Illus. Central States Forest Expt. Sta., Columbus, Ohio. 1955. Tech. Paper No. 146. Mimeog.

The Eucalypts for Tropical Climates Based on Experiences from the FAO. Eucalyptus Study Tour in Australia 1952. By Sukhum Thirawat. 107 pp. Royal Forest Dept., Bangkok, Thailand. 1954.

Growth of Young Ponderosa Pine Stands in the Inland Empire. By D. W. Lynch. 16 pp. Intermountain Forest and Range Expt. Sta., Ogden, Utah. 1954. Research Paper No. 36. Mimeog.

Teak in Thailand. By S. Mahaphol. 31 pp. Royal Forest Dept., Bangkok. 1954. Bul. No. R. 16.

Soils

Amount and Chemical Composition of the Organic Matter Contributed by Overstory and Understory Vegetation to Forest Soils. By D. R. M. Scott. 73 pp. Illus. Yale School of Forestry, New Haven. 1955. Bul. No. 62. $1.50.

Wildlife Management

Bibliography on Snakes, Lizards, Turtles, Frogs, and Salamanders of New Jersey. By M. R. Carriker, A. N. Lentz and J. R. Westman. 8 pp. Illus. Rutgers Univ., New Brunswick, N. J. 1955. Leaflet No. 127.

Nutritional Requirements of White-tailed Deer for Growth and Antler Development. By C. E. French, L. C. McEwen, N. D. Magruder, R. H. Ingram and R. W. Swift. 50 pp. Illus. Pennsylvania State Univ. Agric. Expt. Sta., University Park. 1955. Bul. No. 600.

Plant Pesticides and Wildlife. By P. F. Springer. pp. 101-116. Reprint from 1955 Pesticide Handbook. North Carolina State College, Raleigh.

Red Foxes and a Declining Prey Population. By T. G. Scott and W. D. Klimstra. 123 pp. Southern Illinois Univ., Carbondale. 1955. Monograph Ser. No. 1.

Wood Technology and Utilization

Distribution of Resinous Extractives in Loblolly Pine Lumber After Seasoning. By J. B. Huffman. 4 pp. Illus. Reprint from Apr., 1955, Forest Products Jour. Ltd. distrib. by author, Univ. of Florida School of Forestry, Gainesville.

Kiln-Drying Oregon Maple Paper Roll Plugs. By B. G. Andersen. 4 pp. Illus. Oregon Forest Products Lab., Corvallis. 1955. Rept. No. D-3. Mimeog.

Wood Handbook . . . U. S. Forest Products Lab., Madison 5, Wis. 528 pp. Illus. 1955. U. S. Dept. of Agric. Agriculture Handbook No. 72. $2.00 paper cover (Govt. print. off.)

Wood Pulp a Basic Fiber; The Story of the Origin, Development and Economic Status of a Great American Industry. 48 pp. Illus. U. S. Pulp Producers Ass'n., Inc., New York 17. 1955.

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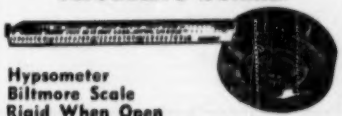
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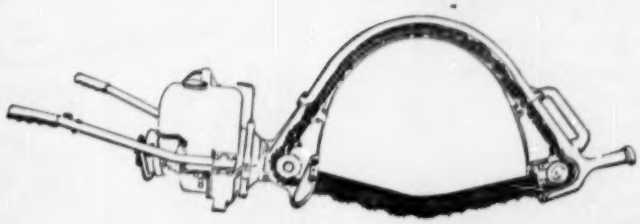
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University of Missouri
Columbia, Mo.

Section Box Score[1]
1955 Membership

Section	Applications received[2] Nov. 1955	Total 1954	Total 1955
Allegheny	0	72	43
Appalachian	1	69	12
Central Rocky Mountain	2	26	8
Central States	0	115	20
Columbia River	2	57	73
Gulf States	8	63	92
Inland Empire	1	40	9
Intermountain	0	15	18
Kentucky-Tennessee	1	5	8
New England	1	54	42
New York	0	39	33
Northern California	2	24	32
Northern Rocky Mountain	1	34	38
Ozark	3	42	22
Puget Sound	1	69	53
Southeastern	1	130	51
Southern California	0	2	3
Southwestern	0	7	11
Upper-Mississippi Valley	0	55	34
Washington	0	8	2
Wisconsin-Michigan	2	13	27
Totals	26	939	631

[1]Adjusted to new record year—now calendar-year basis.

[2]Student, Junior, Affiliate, Associate (initial) grades only.

School Box Score[1]
1955 Membership

School	Student applications received Nov. 1955	Total 1954	Total 1955
Alabama Polytechnic Institute	0	25	11
University of California	0	11	17
Colorado A & M College	0	18	5
Duke University	0	13	2
University of Florida	0	8	7
University of Georgia	0	35	14
University of Idaho	0	29	4
Iowa State College	0	21	15
Louisiana Polytechnic Institute	0	0	13
Louisiana State University	0	14	30
University of Maine	0	20	12
University of Massachusetts	1	12	5
Michigan State College	0	43	10
University of Michigan	0	28	14
University of Minnesota	0	23	11
University of Missouri	0	14	3
Montana State University	0	19	21
State University of New York	0	22	23
North Carolina State College	0	39	0
Oregon State College	0	18	19
Pennsylvania State University	0	37	32
Purdue University	0	26	4
Utah State Agricultural College	0	9	12
University of Washington	0	35	23
West Virginia University	0	22	6
Yale University	0	4	16
Totals	1	545	329

[1]Adjusted to new record year—now calendar-year basis.

Fellows to be Named by Electors

Eminent foresters who have been nominated by petition for advancement to the grade of Fellow will be considered by the electors during November. Successful nominees will be named at the time of the regular elections on December 3.

Selection is by an electoral board composed of present Council members and Fellows, and a favorable vote of half or more of the ballots cast is required for election.

At the close of nominations on October 1, the following Members had been nominated for Fellow:

Reed W. Bailey, Ogden, Utah
Willis M. Baker, Hiwassee Dam, N.C.
John S. Boyce, New Haven, Conn.
Robert W. Cowlin, Portland, Ore.
Dwight B. Demeritt, Bangor, Me.
Samuel B. Detwiler, Boulder, Colo.
James F. Dubuar, Wanakena, N. Y.
Stanley G. Fontanna, Ann Arbor, Mich.
Bernard Frank, Washington, D. C.
Louis J. Freedman, Old Town, Me.
Charles G. Geltz, Gainesville, Fla.
S. R. Gevorkiantz, St. Paul, Minn.
J. Alfred Hall, Madison, Wis.
Paul A. Herbert, East Lansing, Mich.
Willard R. Hine, Atlanta, Ga.
Julius V. Hofmann, Raleigh, N. C.
Frank H. Kaufert, St. Paul, Minn.
F. Paul Keen, Berkeley, Calif.
Chas. J. Kraebel, Berkeley, Calif.
C. Otto Lindh, Albuquerque, N. Mex.
Gordon D. Marckworth, Seattle, Wash.
Arthur C. McIntyre, Harrisburg, Pa.
Nicholas T. Mirov, Berkeley, Calif.
Clarence W. Richen, Portland, Ore.
T. Schantz-Hansen, Cloquet, Minn.
Edwin H. Steffen, Pullman, Wash.
Raymond F. Taylor, Juneau, Alaska
Arthur T. Upson, Tucson, Ariz.
Philip C. Wakeley, New Orleans, La.
R. H. Westveld, Columbia, Mo.
Herman Work, Staunton, Va.

Biennial Election

Ballots for the regular biennial election were sent to the 8986 voting members of the Society the latter part of October. These ballots will be counted on December 3 and the newly elected officers and Council members will take office January 1, 1956 for term 1956-1957.

Photographs of the nominees are carried herewith in one issue for the convenience of members. We have published monthly lists in Society Affairs as nominations were received.

Members are urged to read "Making Your Vote Count in the 1955 SAF Election" on page 868 of this issue.

Nominees For President

GEORGE B. AMIDON. Director of forest management, Minnesota and Ontario Paper Co., International Falls, Minn.

GEORGE A. GARRATT. Dean, School of Forestry, Yale University, New Haven, Conn.

DEWITT NELSON. Director, Dept. of Natural Resources, Sacramento, Calif.

Nominees For Member of the Council

B. E. ALLEN. Superintendent of land acquisition and conservation, Union Bag & Paper Corporation, Savannah, Ga.

N. T. BARRON. Chief forester, Camp Manufacturing Company, Franklin, Va.

PHILIP A. BRIEGLEB. Director, Southern Forest Experiment Station, New Orleans, La.

RANDOLPH M. BROWN. Professor, School of Forestry, University of Minnesota, St. Paul, Minn.

C. HUXLEY COULTER. State forester, Florida Forest Service, Tallahassee, Fla.

STANLEY G. FONTANNA. Dean, School of Natural Resources, University of Michigan, Ann Arbor, Mich.

PAUL M. GARRISON. Chief forester, Gaylord Container Corporation, Bogalusa, La.

MAURICE K. GODDARD. Secretary, Pennsylvania Department of Forests and Waters, Harrisburg, Pa.

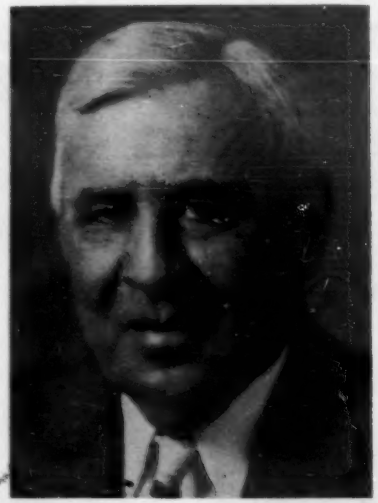
PERCY D. HANSON. Regional forester, U. S. Forest Service, Missoula, Mont.

VERNE L. HARPER. Assistant chief, Branch of Research, U. S. Forest Service, Washington, D. C.

GEORGE B. HARTMAN. Head, Department of Forestry, Iowa State College, Ames, Iowa.

EDWIN F. HEACOX. Managing forester, Weyerhaeuser Timber Company, Tacoma, Wash.

WILLIAM P. HOUSE. Consulting forester, Chesham, N. H.



JOSEPH S. ILLICK. Dean emeritus, College of Forestry, State University of New York, Syracuse, N. Y.

EDWARD N. MUNNS. Retired from Branch of Research, U. S. Forest Service, Concord, Calif.

HARROD B. NEWLAND. State forester, Division of Forestry, Department of Conservation, Frankfort, Ky.

ALBERT D. NUTTING. Forest commissioner, State of Maine Forest Service, Augusta, Me.

CHESTER J. OLSEN. Regional forester, U. S. Forest Service, Ogden, Utah.

RICHARD J. PRESTON. Dean, School of Forestry, North Carolina State College, Raleigh, N. C.

HERBERT J. STONE. Regional forester, U. S. Forest Service, Portland, Ore.

HENRY J. VAUX. Dean, School of Forestry, University of California, Berkeley, Calif.

GEORGE O. WHITE. State forester, Missouri Conservation Commission, Jefferson City, Mo.

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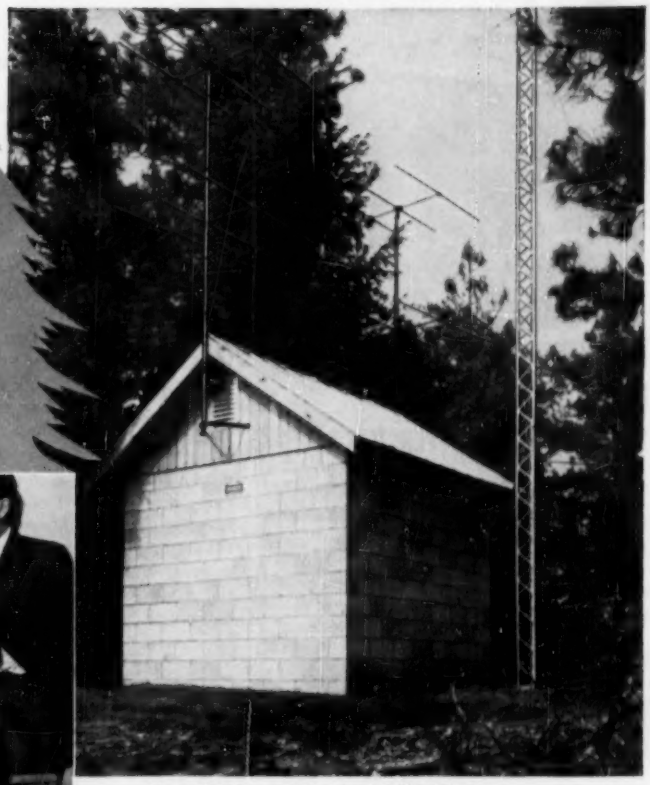

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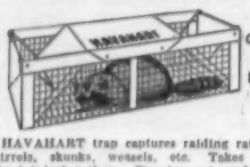

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Making Your Vote Count In the 1955 SAF Election

The 1955 elections will mark the 14th anniversary of the Hare System of Proportional Representation ("PR") in SAF elections. This method was adopted in 1929 and has been in use ever since.

The Hare System has consistently met the test of efficiency and fairness wherever it has been applied. Many municipalities and private associations have found it the soundest means of electing officers and directors most representative of their voting groups. Briefly, this scientifically devised system (1) provides representation to minority groups, (2) assures majority rule to an extent far superior to that possible by any other system of election, and (3) permits each voter (or member in good standing) to vote for the candidates he really wants, whether or not he thinks they are likely to be elected.

The only basic requirement which voters have to meet is to mark their ballots properly. This is simplicity itself. All the voter need do is to mark number *1* opposite the name of his first choice candidate, number *2* opposite the second choice, and so on *all the way down the entire list of candidates.* Thus the completely effective ballot would be one that provided a different "rating" for each candidate listed (no duplicating numbers) irrespective of the number of position to be filled. In the case of SAF elections this procedure applies equally to the respective ballots for Council, and for *President* (and Vice President). It prevents the wasting of votes and gives effect to every vote to which it is possible to give effect.

There are excellent reasons for this procedure, as the following brief description brings out.

When the Society's Teller Committee receives the ballots, they are tabulated initially by first choice votes. Any ballot which fails to show a clear first choice—i.e., exhibits duplicate numbers, check marks, or X's—is thrown out as invalid. In the 1947 election, 3 percent of the ballots were invalid for these reasons; in 1949, about 4 percent. In 1951, however, the ratio fell to 0.8 percent, and in 1953 to less than 0.6 percent. (Some additional ballots in 1953 were invalid because they were received too late or lacked signatures.)

Candidates who receive enough first choice votes to meet the quota (total number of valid ballots divided by one plus the number of positions to be filled, plus one) are immediately declared elected, and their surplus votes are transferred to the voters' *second choice* candidates. Similarly, the candidate receiving the fewest first choice votes is declared defeated, and his ballots transferred to the voters' respective second choice candidates. This process continues via a series of transfers until all candidates are declared either defeated or elected.

The importance of placing a number after each and every candidate's name is illustrated by the 1951 election in which 12 separate transfers were required to elect the nine Council members, and 3 transfers to elect the President and Vice President. In the Council election, the voters did very well. Less than 0.7 percent of the ballots had to be eliminated from the later transfers because the voters concerned had failed to indicate enough choices beyond the nine to be elected. Had every voter marked down a number for each of the 20 candidates for these nine positions, every candidate would thus have been assured of equal consideration until either defeated or elected. Strangely enough, over 36 percent of the ballots for President were ineffective in the third transfer because these voters had not taken the trouble to indicate more than two choices out of the five candidates listed.

The 1951 election was unique in that for the first time the ballots were tabulated by hand instead of by machine. Thirteen people took part in

Duane M. Covington (1903-1955)

Duane M. Covington, resident manager of the University of Washington Charles Lathrop Pack Demonstration Forest, was killed in a construction accident on the forest on September 13. He had been resident manager of the forest since 1929 and lived in La Grande.

Born in Fort Collins, Colo., in 1903, he graduated from the University of Washington College of Forestry in 1927. During World War II he was a lieutenant in Air Force Intelligence.

He was a Member of the Society of American Foresters and was active in the work of the Puget Sound Section. He was a member of Xi Sigma Pi, forestry honorary fraternity, and past national vice president of Tau Phi Delta, forestry social fraternity.

the sorting and counting, thereby gaining a first-hand knowledge of how "PR" works. A similar number participated in the 1953 count. So far as these participants are concerned, the Society can feel assured that all of them will mark their ballots effectively!

One effective way of obtaining a practical acquaintanceship with the Hare System is to "play-act" an actual election. In 1954, at the request of the Allegheny Section, the author arranged such a demonstration at the Section's annual meeting. In lieu of casting ballots, the voters distributed themselves around chairs occupied by the respective candidates for Council, according to their first preference. As each candidate was declared "elected" or "defeated," the surplus voters walked to the chairs of their next choice candidates, continuing the transfer process until the required number was elected. By the end of the election, each successful candidate was surrounded by the required quota of voters, while the unsuccessful candidates sat alone.

Further details on "PR" can be obtained from the article, "The Hare System of Proportional Representation and How it Works" in the September 1951 issue of the JOURNAL OF FORESTRY.

BERNARD FRANK
Chairman, Teller Committee, S.A.F.

The President's Column

E. L. DEMMON

A great majority of the professional foresters in America are members of our Society and working towards its objectives, one of which is to represent, advance, and protect the interests and standards of our profession. Inasmuch as we in the Society consider forestry a profession and since the general public is increasingly aware that forestry is a profession, we have the obligation of conducting ourselves as professional men. The details of proper professional conduct have been spelled out in our Code of Ethics adopted some years ago. This code, covering 25 separate points, lists the rules governing a forester's professional life, his public responsibilities, his relation to his employer, and his obligations to his fellow foresters. In addition, foresters have certain other professional obligations, some of which I will touch on here.

A professional forester should keep up with advances in technical knowledge if he is to do his job adequately. His education does not stop with a diploma from a forestry school or its equivalent before he enter the profession; he must keep up to date with the literature in the broad field of forestry and with developments in forestry practices. He can do this in large part through such publications as the JOURNAL OF FORESTRY and the new quarterly, *Forest Science*, and by attendance at Society meetings—local, regional, and national.

Every professional forester should be a member of and contribute to his national organization, of which the Society of American Foresters is the only one that operates on an entirely professional basis. This obligation includes attendance at and taking an active part in meetings at the local (Chapter), regional (Section), or national level. When called upon he should serve on programs, on commitees, or as an officer. He should help elect officers who will adequately represent him and the profession; he should contribute to the JOURNAL if he has something worthwhile to present; and he should do what he can to improve the Society through his own efforts or by offering constructive suggestions. If he is not satisfied with the Society as it is, he should make an effort to effect changes. He should not neglect his privilege of voting for officers and contributing to Society affairs.

A professional forester should take every opportunity to bring his profession to the attention of the public. He can do this in many ways, such as through proper publicity, but mainly by his own example as a professional man, including how he manages his own forest or his employer's forest. Although not all foresters will agree on what is the most desirable forest management, there are certain principles to which all foresters subscribe.

Finally, it is up to each forester individually to carry out his professional obligations. We in America live in a

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free society. No forester can be forced to join our Society of American Foresters. But none of us lives in a vacuum. People are still more or less dependent on one another. Foresters have certain responsibilities to their employers as well as to society as a whole. And a forester's standing in his community and in his profession depends on the way he lives up to his professional responsibilities.

Foresters have greater opportunities than many other professional men to leave living memorials behind them. I urge every Society member to take full advantage of his opportunities to represent, advance, and protect the interests and standards of our profession—one of the guiding policies of our Society.

E. L. Demmon

New England Section Meeting

The annual summer meeting of the New England Section was held September 7 and 8 at the University of Massachusetts, Amherst.

The program for the first morning consisted of a field trip to Colrain State Forest. Plantations established by the Massachusetts State Forest Service in 1910-1911 were inspected, as well as other areas of silvicultural interest. In the afternoon a visit was made to the Healy Tree Farm to inspect cuttings made by the New England Forestry Foundation foresters.

In the evening the Section members held a short business meeting at which Chairman William P. House presided. Henry Clepper briefly discussed national Society affairs.

There was an exhibition and explanation of vegetation and land type maps now in preparation for the state. Dr. H. H. Chapman and Prof. Karl W. Woodward received fifty-year anniversary citations from the U. S. Forest Service, presented by Regional Forester Charles L. Tebbe.

On the following morning, a field trip was made to the University forest near Mt. Toby to view plantation thinnings and management practices. The meeting adjourned at noon on September 8.

Nearly 100 members and guests were in attendance.

Membership Applications and Advancements

Proposals for admission, advancement, and reinstatements received in the Society office during the month of September are listed below.

Action on the eligibility of those proposed for membership as listed below will be taken by the Council as of December 1, 1955. Communications from voting members regarding the membership eligibility of these persons should be received in the Society office prior to that date.

Allegheny Section

Junior Grade

Betler, G. A., 110 W. 7th St., Weston, W. Va. Reinstatement.

Nicholson, R. L., Box 226, Ligonier, Pa. Reinstatement.

Appalachian Section

Junior Grade

Fuller, G. R., Box 426, Elkin, N. C. Reinstatement.

Affiliate Grade

Hubble, W. A., Service Forester, Va. Forest Service, Tappanhannock, Va.; V.P.I., B.S., (Forestry), 1951.

Central Rocky Mountain Section

Junior Grade

Sackschewsky, M. L., 828 W. Olive, Fort Collins, Colo.; Colo. A & M, B.S.F., 1954.

Williamson, C. E., Forester, U.S.F.S., Briggsdale, Colo. Reinstatement.

Zimmermann, G. P., 2445 7th St., Boulder, Colo.; Colo. A & M, B.S.F., 1954.

Member Grade

Barney, C. W., Head, Dept. of Forest Mgmt., Colo. A & M, Fort Collins, Colo. (Junior, 1948).

Blankenship, F. E., Forester, Colo. Board of Land Comm., Denver, Colo. (Junior 1948).

Hardy, G. M., Ranger, U.S.F.S., Winter Park, Colo. (Junior, 1948).

Newport, C. A., Asst. Prof., Colo. A & M, Fort Collins, Colo. (Junior, 1948).

Central States Section

Affiliate Grade

Easley, A. K., Box 297, Brownstown, Ind. Reinstatement.

Columbia River Section

Junior Grade

Rhodes, M., Box 45, Manzanita, Ore. Reinstatement.

Affiliate Grade

Litton, K. M., Forester, Bur. of Indian Affairs, Toppenish, Wash.; Okla. A & M, B.S., (Forestry), 1954.

Schmitt, A. L., Forester, Bur. of Land Mgmt., Medford, Ore.

Gulf States Section

Junior Grade

Baker, B. M., Forester, U.S.F.S., Oxford, Miss.; State Univ. of N. Y., B.S.F., 1950.

Gerred, D. L., Forester, U.S.F.S., Oxford, Miss. Reinstatement.

Verrall, A. F., Pathologist, U.S.F.S., Gulfport, Miss. Reinstatement.

Wolfel, G. A., Forester, U.S.F.S., Oxford, Miss.; Univ. of Mo., B.S.F., 1950.

Affiliate Grade

Barnett, H. L., Area Forester, Gaylord Container Corp., Walker, La.

Dunn, J. E., Research Forester, U.S.F.S., Alexandria, La.; Okla. A & M, B.S., (Forestry), 1955.

Fuston, F. P., Forest Tech., International Paper Co., Alexandria, La.; Stephen F. Austin State College, B.S., (Forestry), 1955.

Hoover, C. F., Project Forester, U.S.F.S., Senatobia, Miss.; V.P.I., B.S., (Forestry), 1952.

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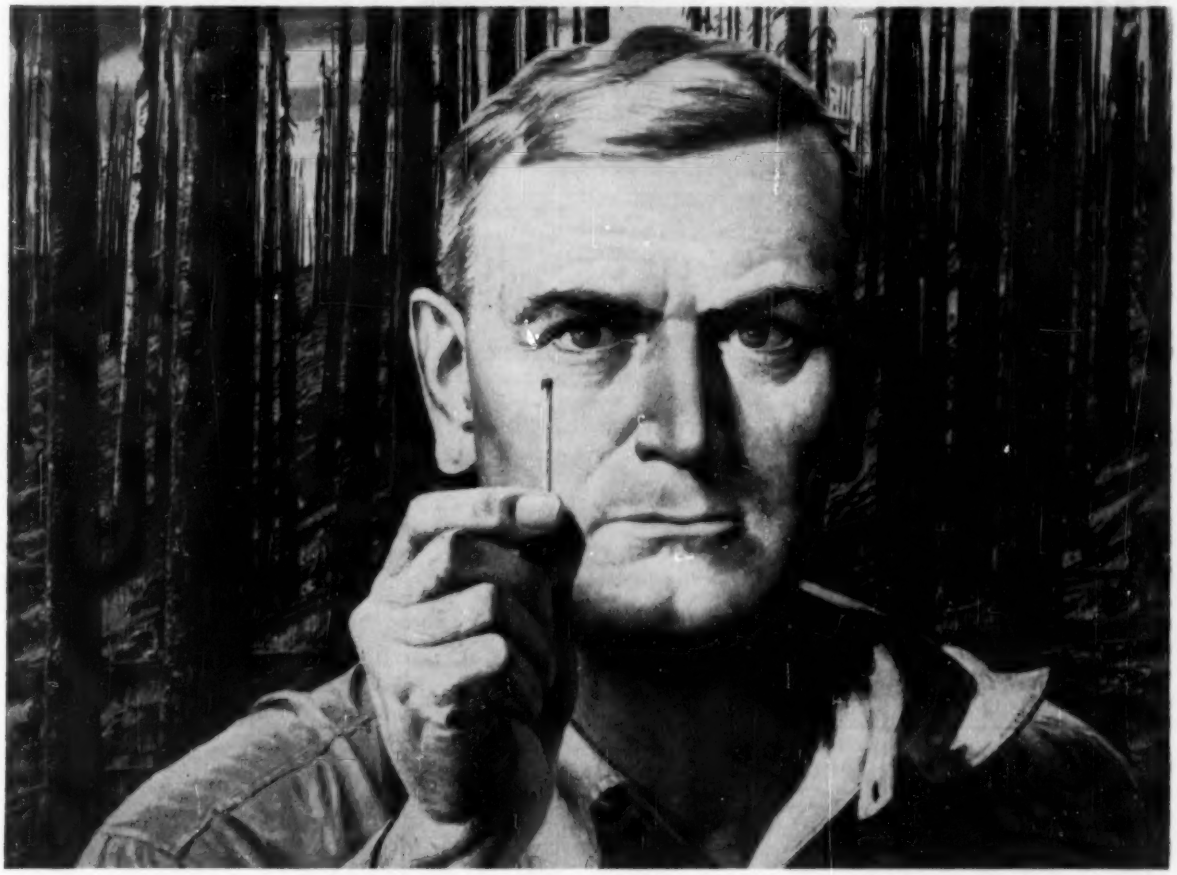

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OLD TOWN, MAINE
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McMahon, B. A., Supt. Wood Procurement, East Texas Pulp & Paper Co., Silsbee, Texas.
Associate Grade
Goodrum, P. D., Wildlife Research Biologist, U. S. Fish & Wildlife Service, Nacogdoches, Texas; Texas A & M, M.S., (Wildlife Mgmt.), 1938.

Inland Empire Section
Junior Grade
Schultz, A. E., Forester, Potlatch Forests Inc., Headquarters, Idaho; Univ. of Minn., B.S.F., 1949.

Intermountain Section
Junior Grade
Buchman, R. B., 62 Lower Row, Magna, Utah. Reinstatement.

Kentucky-Tennessee Section
Junior Grade
Schaney, A. L., Service Forester, Ky. Div. of Forestry, Prestonsburg, Ky. Reinstatement.
Associate Grade
Vaughan, J. W., Agric. & Forestry Agent, Ill. Central Railroad, Jackson, Tenn.; Univ. of Tenn., B.S., (Agric.), 1939.

New England Section
Student Grade
UNIVERSITY OF MASSACHUSETTS
Romancier, R. M.

New York Section
Junior Grade
Barrus, G. L., 220 Latta Rd., Rochester, N. Y. Reinstatement.

Northern California Section
Junior Grade
Hess, D. E., Asst. Forest & Rge. Officer, State of Calif., Sacto. Calif.; Univ. of Idaho, B.S.F., 1961.
Shera, H. R., Lumber Worker, Hammond Lbr. Co., Eureka, Calif.; Univ. of Calif., B.S.F., 1952.

Northern Rocky Mountain Section
Junior Grade
Bushfield, J. P., Forester, U.S.F.S., Libby, Mont.; Utah State Agric., B.S.F., 1951.

Ozark Section
Junior Grade
Wickstrom, E. B., Asst. Dist. Forester, Dierks Forests Inc., Eagletown, Ok'a.; Univ. of Minn., B.S.F., 1951.
Affiliate Grade
Bartholomew, W. C., Asst. Dist. Forester, Dierks Forests Inc., Nashoba, Okla.; Okla. A & M, B.S., (Forestry), 1955.
Morrison, J. B., Forest Tech., International Paper Co., Hampton, Ark.; Ark. A & M, B.S., (Forest Mgmt.), 1954.

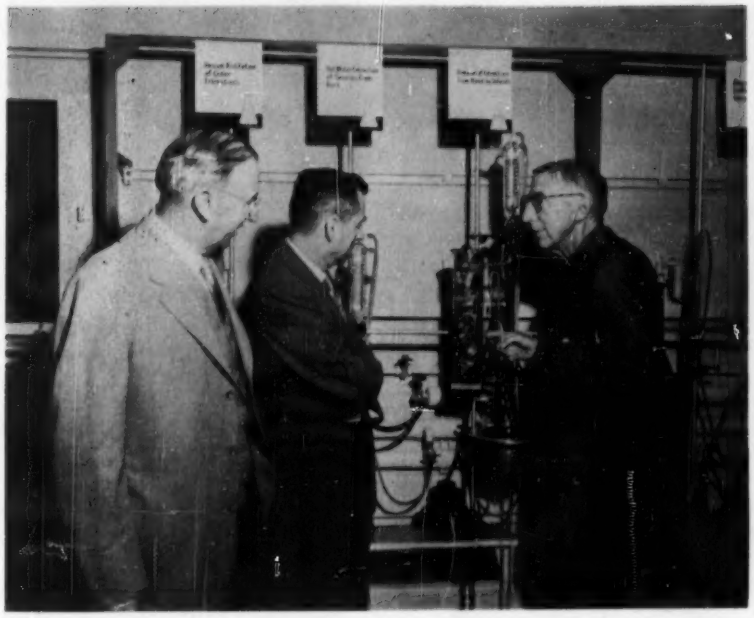
Puget Sound Section
Junior Grade
Bowman, N. B., Route 1, Monroe, Wash. Reinstatement.
Brady, R. C., Chief Forester, U. S. Plywood Corp., Kosmos, Wash. Reinstatement.
Anderson, R. W., Forester, U.S.F.S., Quinault, Wash. Reinstatement.
Affiliate Grade
Strege, R. A., Chief Fire Warden, Puget Sound Pulp & Tbr. Co., Clear Lake, Wash.

Southeastern Section
Junior Grade
Darby, S. P., Rt. 6, Hitchock Rd., Macon, Ga. Reinstatement.
Orr, J. V., Asst. Forest Supv., Hudson Pulp & Paper Corp., Shamrock, Fla. Reinstatement.
Affiliate Grade
Freeman, R. H., Jr. Forester, U.S.F.S., Centreville, Ala.; Ark. A & M, B.S., (Forestry), 1955

Wisconsin-Michigan Section
Junior Grade
Davis, J. R., Area Forester, Wis. Cons. Dept., Spooner, Wis.; Univ. of Minn., B.S.F., 1952; M.F., 1953.
Affiliate Grade
Raisanen, R. R., Asst. Forester, Upper Peninsula Power Co., Houghton, Mich.; Mich. College of Mining & Tech., B.S., (Forestry), 1951.

Foreign
Junior Grade
Crosby, M. R., Firestone Plantations Co., Harbel, Liberia, W. Africa. Reinstatement.
Corresponding Grade
Becking, R. W., Forester, State Forest Service, Haarlem, Netherlands; Univ. of Wash., Ph.D., (Silviculture), 1954.

Forestry News



INSPECTING WORKING EXHIBIT on removal of extractives from wood by solvents during dedication of Crown Zellerbach's new Central Research Laboratory at Camas, Washington, September 14, 1955, are (*l.* to *r.*) E. P. Stamm, Crown Zellerbach's vice president for Northwest Timber Operations; Truman Collins, director, Crown Zellerbach, director and president of Collins Pine Company; and Col. W. B. Greeley who was banquet speaker that evening.

Crown Zellerbach Dedicates New Research Laboratory

The dedication of Crown Zellerbach Corporation's new Central Research Laboratory at Camas, Washington was held September 14 with Harold L. Zellerbach, executive vice president, heading a group of business and scientific leaders in the dedication ceremony.

The $600,000 laboratory contains the latest in facilities and equipment for pulp and paper research, and one of the finest scientific libraries in the pulp and paper industry. It also houses the company's new Chemical Products Division under Dr. W. M. Hearon, which is responsible for creative research on new by-products from the pulp and paper making process. The new laboratory adjoins the Development Laboratory, completed in 1952, consisting of a complete experimental pulp and paper mill.

Following Mr. Zellerbach's outdoor dedication speech, R. T. Kimberlin, vice president for Corporate Develop-

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ment, outlined the company's research policies and goals at a meeting in the building's new auditorium. Dr. Moyer and other members of the research staff talked on the scope of paper, fiber, and process development research.

Colonel William B. Greeley, retired Chief of the U. S. Forest Service, prominent industrial forester, talked on "New Horizons in Wood" at the evening banquet. He discussed points in the history of forest products research in the United States, its vast contributions to forest industries, and pointed to its future task of making the forest products industries all product industries.

The bronze plaque which is permanently mounted at the entrance to Crown Zellerbach's new research library bears the statement: "Our future lies in the trees and in what secrets we yet may, through research, gather from them."

Government

Clare Hendee Named Assistant Chief, Other Forest Service Personnel Changes Announced

The U. S. Department of Agriculture has announced the reassignment of several federal foresters, following the recent appointment of Earl W. Loveridge, former assistant chief of the Forest Service in charge of administrative management and information, as agricultural attache at Bogota, Colombia.

Clare W. Hendee, regional forester for the California Region, with headquarters in San Francisco, will succeed Mr. Loveridge.

Charles A. Connaughton, regional forester for the Southern Region, with headquarters in Atlanta, will succeed Mr. Hendee in San Francisco.

C. Otto Lindh, of Albuquerque, New Mexico, regional forester for the Southwestern Region, will succeed Mr. Connaughton in Atlanta.

Fred H. Kennedy, of Denver, chief, Division of Range Management in the Rocky Mountain Region, will succeed Mr. Lindh as regional forester for the Southwest.

The reassignments, which became effective about October 1, place foresters in areas of responsibilities where their training and background will be of greatest value to the regions concerned, according to Richard E. McArdle, chief of the Forest Service.

Michigan Steps Up Planting Program

The Michigan Department of Conservation has announced the addition of 25 new tree planting machines to its previously operated 17 in an accelerated planting program on state lands. The new machines were designed and constructed at the department's forest fire experiment station near Roscommon.

Michigan's planting program calls for completion of 10,000 acres this fall and next spring, 15,000 acres in each of the next two years, and 20,000 each year thereafter until a currently available 250,000 acres have been planted.

HAMILTON K. PYLES

RICHARD J. COSTLEY

H. K. Pyles Promoted to Washington Position, Succeeded by R. J. Costley

Hamilton K. Pyles, who since July 1952 has been chief of the Division of Information and Education of the North Central Region of the U. S. Forest Service, has been appointed to a staff position in the Branch of National Forest Resource Management at Washington, D. C. Pyles was formerly forest supervisor of the Cleveland National Forest in California and is a University of California forestry graduate.

Richard J. Costley succeeds Pyles in the North Central Region. He was formerly supervisor of the Allegheny National Forest, Warren, Pa. He holds a B.S. degree in forestry from Utah State Agricultural College and a master's degree from the University of Illinois. He served with the Navy during World War II in the Philippines, and Korea. He then became assistant chief of the Division of Wildlife Management in the Washington office of the Forest Service in 1946, and moved to the Allegheny forest in 1949.

H. D. Miller to Head Southeast Wildlife Program

District Ranger H. Donald Miller of the Chesnimnus District on the Wallowa-Whitman Forest at Enterprise, Ore., has been promoted to take charge of wildlife management activities in the Southeastern Region of the U. S. Forest Service with headquarters at

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Atlanta, Ga.

Miller studied in the wildlife field at Washington State College from which he graduated in 1938.

In his new assignment in the southeast, Miller will be responsible for the cooperative wildlife management projects now being carried on between the states and the U. S. Forest Service including such wildlife units as the Pisgah National Game Preserve.

Supervisors Named in North Central Region

Transfer of personnel affecting three key national forests in the North Central Region, has been announced by Mr. H. Dean Cochran, regional forester for the U. S. Forest Service at Milwaukee, Wis.

Dan E. Bulfer, for over 5 years forest supervisor of the Nicolet National Forest in northern Wisconsin, will fill a vacant supervisor's position on the Chippewa National Forest with headquarters at Cass Lake, Minnesota.

Edward N. Lee, of Harrisburg, Illinois, headquarters of the Shawnee National Forest, is being transferred to Rhinelander to succeed Mr. Bulfer.

Lawrence P. Neff, until recently assistant to the chief of operation in the Milwaukee regional office, will take over the forest supervisor's position on the Shawnee which administers national forest areas in southern Illinois and southeastern Missouri.

C. G. Fredine Heads N.P.S. Wildlife Work

C. Gordon Fredine has been named principal biologist of the National Park Service, going to that position from the Fish and Wildlife Service where he was chief of the Drainage Studies Section, Office of River Basin Studies. Fredine received his B.S. in biology from Hamline University in 1932 and did graduate work in wildlife management at the University of Minnesota. During World War II, while in the Navy, he carried on insect-borne disease control work in the Pacific.

Rocky Mountain Experiment Station Expands Research

A new research center in the Black Hills, a skyline-crane logging system at Fraser Experimental Forest in Colorado, and a study of plant-water relationships in the Southwest have been installed under the expanded research program of the Rocky Mountain Forest and Range Experiment Station, Director Raymond Price announced recently.

These are some of the personnel appointments and transfers resulting from the expansion:

Richard M. Hurd, a research forester who for the past 5 years has been in charge of the station's field unit in Laramie, Wyoming, has been selected to head the new unit in the Black Hills. Headquarters have been established in Rapid City, South Dakota.

In cooperation with other agencies, this new research unit will seek to (1) develop markets for below-sawtimber-sized material, such as pulpwood, poles, and fence posts; (2) improve current practices in using wood; (3) increase productivity and quality of the timber resource; (4) coordinate livestock grazing with range use by deer and other big game; and (5) determine the effect of present forest use on water resources.

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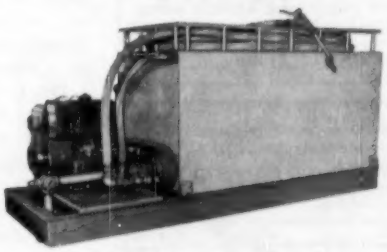

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S. Clark Martin, range conservationist from the Central States Forest Experiment Station, has been selected to replace Mr. Hurd at Laramie. Since 1949, Mr. Martin has been conducting range research in the Ozark region of Missouri.

Francis R. Herman has been transferred from the station's research center in Flagstaff, Arizona, to take charge of the first skyline-crane logging operation to be tested in the Central Rockies. This unique cable system was developed in Europe by Jacob Wyssen to handle tough logging shows on steep slopes in rugged terrain with a minimum of damage to the site. Location of the installation is West St. Louis Creek, just above President Eisenhower's favorite fishing grounds near Fraser, Colorado.

Region 2 of the Forest Service and the Koppers Company are also cooperating in the experiment.

Dr. John P. Decker, scientist and plant physiologist, has been appointed to carry out important research in plant-water relationships in the Southwest. Dr. Decker is a well known authority on photosynthesis and plant respiration. He comes to the station from the Brooklyn Botanical Gardens in New York and has been assigned to the field unit in Tempe, Arizona.

Frank M. Yasinski is being transferred from station headquarters in Fort Collins, Colorado, to conduct insect surveys in Arizona and New Mexico. He will work with the station's Forest Insect and Disease Laboratory in Albuquerque.

Dr. C. L. Massey, also from Fort Collins, was recently transferred to take charge of this new laboratory.

In 1953, the Rocky Mountain Forest and Range Experiment Station, a branch of the U. S. Forest Service, in the Department of Agriculture, was reorganized to include the Southwestern Station. Under the new organization, the station now conducts research in six major fields (forest management, range management, wildlife, watershed management, forest insects, forest disease, and forest utilization) throughout South Dakota, Nebraska, Kansas, Wyoming, Colorado, Arizona, New Mexico, and west Texas, Director Price explained.

George Spaur Leaves Oregon Post, Succeeded by D. L. Phipps

George Spaur, Oregon state forester, resigned his position effective October 1 to accept a post with the International Cooperation Administration as advisor to the Minister of Forests for East Pakistan. He has been succeeded by Dwight L. Phipps, deputy state forester.

Spaur has served as Oregon's state forester since 1949 when he succeeded the late Nelson S. Rogers. He was the sixth man to hold that position since its creation in 1911. He joined the state forestry department in 1937, serving as staff forester and later as deputy state forester.

During World War II Colonel Spaur served as a staff officer with the Ninth Army Corps in the Pacific and during the Japanese occupation assisted in making an economic survey of the Japanese Islands. He commanded the 369th Engineer Boat and Shore Regiment during the Korean emergency and also served as post commander of Fort Worden, Wash., and chief of staff at the 1952 atomic bomb tests at Desert Rock, Nev.

In his new position Spaur will serve as director of American technicians in East Pakistan and will also carry responsibility for directing the Research Center at Chitagong. The cooperative aid program is carried on under the U. S. Department of Agriculture and the State Department.

Phipps has been with the state service in Oregon since 1925, becoming assistant state forester in charge of protection in 1942. He became deputy state forester in 1950 and served as state forester for two years during the absence of Spaur during the Korean emergency.

No Strip Mining in Cumberland National Forest

The Stearns Coal and Lumber Company of Stearns, Ky., will not be permitted to strip mine coal in the Cumberland National Forest. This decision climaxed an appeal by the com-

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pany to Secretary of Agriculture Ezra Taft Benson from an earlier finding by the regional forester who had ruled that the operation would not be in the public interest.

The consultant board appointed by the Secretary to investigate the company's request consisted of Charles P. Taft, attorney from Cincinnati, Ohio; R. L. Wilhelm, mining engineer of St. Clairsville, Ohio; and Samuel T. Dana, dean emeritus of the School of Conservation, University of Michigan.

The land that the company sought to work was sold by it in 1937 to the federal government subject to reservation of the mineral rights. Since that time it has been managed by the U. S. Forest Service, and with the forest cover restored, has become valuable for watershed protection purposes, timber production, and recreation.

The consultants determined that in view of the topography of the land the strip mining operation would create a serious water pollution problem, would interfere with and disrupt the management of the land for forestry purposes, and would leave it in an unsightly condition that would impair its recreational values. The expense of subsurface mining ruled that approach out and, the board found, that if the company was required to restore the stripped land, it would not be able to market the coal at anywhere near the going price. Public hearings in the area of the national forest brought out a great interest in the lands for values other than for what coal they might contain.

Results of Mangement Assistance Under Study by TVA

Tennessee Valley Authority, in cooperation with the forestry and agricultural extension agencies of the seven Tennessee Valley states, has begun an evaluation of progress on some 600 forest properties whose owners received specific forest management recommendations over the past 14 years. Richard Kilbourne, director of TVA's Division of Forestry Relations, said the purpose of the study is to find out exactly what has happened on these case examples—why they succeeded or failed, as the case may be. The study is scheduled for completion early next spring.

The cases to be reviewed include all kinds of ownership—farm, industrial, investment, institutional, state, municipal. The total area is about 580,000 acres. In every case, the owner received technical aid on management through the joint efforts of TVA and the state forestry and extension agencies. Each woodland contained enough merchantable timber to enable the owner to begin management of no out-of-pocket expense.

Richard Marden Appointed to Lake States Station

Richard M. Marden, has joined the staff of the Lake States Forest Experiment Station, which has its headquarters in St. Paul, Minn. Marden will assist in the wood utilization research program at the Station's field office in Wausau, Wisconsin.

A veteran of World War II, Marden is a graduate of the University of Minnesota and obtained a master's degree from that institution in 1951. During the past year he has been teaching and doing graduate work at the University. He served as chief forester for the Homestake Mining Company in Lead, South Dakota, between 1948 and 1954.

Education

Yale Holds Second Industrial Seminar

Top executives in the field of industrial forestry will become students again when they convene at Yale University in November for a series of seminar refresher courses in forest management and industrial administration.

The session will be held November 7-18 at the Yale Forestry School under the direction of E. T. F. Wohlenberg, professor of industrial forestry, and will be similar in scope to the program held last April 7 for the first time.

Subjects to be covered in the seminar are forest inventories and stand structure studies, business organizations in the forest products industries, income and ad valorem taxes in relation to operating costs, labor relations and collective bargaining, integration and research in the forest industries, and public relations in forestry.

Teachers for the seminars will include Yale faculty members as well as leading experts both in government and in business.

Enrollment for the November seminar will be limited to approximately 20 men, and will be closed when that number is reached, according to Dean George H. Garratt of the School of Forestry.

Floyd Hart Scholarship Established at Oregon

A scholarship fund for future foresters at Oregon State College has been established in recognition of the outstanding public services in the field of forestry by the late Floyd Hart of Medford, Ore., lumberman member of the Oregon State Board of Forestry.

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Participation in the Floyd Hart Scholarship Fund is directed by the committee for contributions, composed of Albert Powers, Coos Bay, chairman; George Spaur, state forester, Salem; Dean W. F. McCulloch, School of Forestry, O.S.C., and Charles E. Ogle, Associated Forest Industries, Salem.

Money contributed to the fund will be used to aid deserving forestry students at the forestry school at Oregon State College.

Industry & Private

Southeastern Fire Compact Ratified

The Southeastern Interstate Forest Fire Protection Compact has been ratified by seven southeastern states and is now in operation, according to South Carolina's State Forester Chas. H. Flory, chairman of the Southeastern State Forest Fire Compact Commission. The main purpose of the Compact is to promote more effective control of forest fires in the southeastern region by authorizing states to assist each other in fire emergencies by furnishing trained personnel, equipment, and other services to combat fires.

J. W. Brown Joins New Hampshire Society Staff

A recent announcement by Edgar C. Hirst, president of the Society for the Protection of New Hampshire Forests, reports that J. Willcox Brown has been appointed assistant forester for the Society. Brown went to his new position from that of assistant professor at the University of Michigan. Lawrance W. Rathbun is Society forester.

Trees for Tomorrow Camp Attendance Soars

M. N. Taylor, executive director, reported that on June 21 attendance at the Trees for Tomorrow camp hit the 20,000 mark. Taylor said reservations this year will total 3,500, of which 1,239 are high school students and their instructors, from 120 high schools throughout the state. The camp opened on March 6. The 1955 reservation schedule continues until November 12th.

Purchase of a 4th tree planting machine was authorized at the annual summer meeting of the board of directors at Eagle River in August.

Folke Becker, chairman of the board, Rhinelander Paper Co. and president of the industry-sponsored organization, said this action was nec-

essary because of the large number of requests to machine plant a million trees for private landowners next spring.

The following representatives of Trees for Tomorrow, now in its 12th year, were present: D. B. Smith, president Wausau Paper Mills Company, secretary-treasurer Trees for Tomorrow Inc.; E. B. Hurst, woodlands manager Consolidated Water Power & Paper Company, vice president Trees for Tomorrow; N. S. Stone, vice president and general manager Mosinee Paper Mills Company; Stanton W. Mead, president Consolidated Water Power and Paper Company; Neil Nash, vice president, and George Kilp, manager woodlands operations Nekoosa-Edwards Paper Company; C. R. Seaborne, vice president, and A. M. Schmalz, production manager Thilmany Pulp and Paper Co.; Ben Cancell, president Rhinelander Paper Company; J. M. Conway, president, and H. G. Wintgens, vice president Charmin Paper Mills, Inc.; Harry Fitze, assistant secretary and treasurer, National Container Corp.; H. P. Taylor, president Wisconsin Public Service Corp.; W. E. Schubert, vice president Wisconsin-Michigan Power Co.; and William Mertens, secretary-treasurer Chippewa and Flambeau Improvement Company.

Pulpwood Representatives Discuss Debarking Problems

Representatives of 20 pulpwood companies, located in 10 states, from Pennsylvania to Louisiana, discussed debarking problems of their industry at an all-day meeting September 14, at Battelle Institute, Columbus, Ohio. The industry meeting was organized and directed by W. C. Finley, Battelle liaison representative to the forest and wood products industry.

To offset the anticipated great increase in pulpwood requirements in the future, pulpwood industry men are looking to mill residues as a potential source of as much as one-third of their current fiber needs. At the present time one of the many obstacles to the use of mill residues, is a quick and economic removal of bark from these residues. Another problem is the separation of bark from chips.

Twenty-five executives from the 20 companies devoted much of the meeting to analyzing research approaches to these problems. They were given a review of the present debarking methods by William T. Reid, Battelle assistant technical director.

Northwest Tree Farm Acreage Continues Increase

Twenty new west coast tree farms were certified on August 30 at a board meeting of the Industrial Forestry Association and additions made to existing tree farms which increased the certified acreage in the Douglas-fir region by 176,801 acres.

Ten of the new tree farms are in Washington and ten in Oregon. They range in size from the 20-acre Pepper Grant tree farm in Island County, Wash., to the 124,694-acre industrial holdings of the Timber Service Company in Linn County, Ore.

Slightly over 230,000 acres have been approved this year in two other certifications in addition to this one. Western Oregon now has 116 tree farms ranging in size from small farm woodlots to large industrial properties on which advanced forestry is being practiced, totaling 1,948,588 acres. Western Washington has 169 with a total of 2,697,755 acres, according to R. F. Morse, Chairman of I.F.A.

Ohio Forestry Association Wins Award

For its public service program, "The Ohio Watershed Conservation Plan," the Ohio Forestry Association, Inc., has been given an Award of Merit by the American Trade Association Executives. The certificate was presented to William Laybourne, executive director of the forestry organization, by Russell A. Stevenson, dean of the School of Business Administration, University of Michigan, at the recent 35th Anniversary Meeting of the executives at Mackinac Island, Mich.

National awards were given to twelve associations which have been of outstanding service to both industry and the public. Three of them, including that to the Ohio Forestry Association, were given on a state or local basis, the others to nation-wide groups. The Ohio award was the only one in the field of conservation.

The project for which the Ohio Forestry Association won recognition stemmed from water shortages since 1953 which have seriously endangered Ohio's economy. A year's research was undertaken by a 70-man committee representing industry, agriculture, communities, and government

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Index to Advertisers

	Page
Allis-Chalmers	856
Atkinson, S. Gayley	873
Audio Equipment	870
Banzhaf & Co., George	872
Bartlett Mfg. Co.	869
Belanger & Bourget	873
Bernard Food Industries	877
Bruns, Paul	870
Calder, Lester E., and Douglas	876
Cards of Wood	851
Caterpillar Tractor	3rd Cover
Clark, Thomas	873
Clifton, Thomas	873
Cranston, Keith	872
Dow Chemical	849
Eastman, Wm. A.	872
Farmcraft Associates	873
Forest Seeds of California	869
Forestry Suppliers	855
Hale Fire Pump	879
Hall, A. G.	873
Hall, Jack	874
Havahart	868
Haynes Mfg. Co.	876
Homelite Corp.	Back Cover
I. E. L. Power Saws	868
Kurfew	861
LaPierre Sawyer	860
Lemieux, Frank J.	872
Lind Co., A. L.	861
Lowther Co., Harry A.	868
Lufkin Rule	860
McCulloch Motors	802
Melin Meteorological Service	859
Motorola	867
Musser Forests	859
Nelson Company	850
Northeast Forestry Service	874
Northern Tree Co.	873
Oregon Saw Chain	851
Panama Pump	875
Pond & Moyer	872
Poulan Saw	861
Prentiss & Carlisle	873
Price, Wm. H.	873
Rich Forest Fire Tool	869
Ronald Press	854
Rootspred	859
Ryker, Harrison C. Inc.	861
Sandvik Saw & Tool	851
Schultz, C. D. & Co., Ltd.	872
Sebrell Corp., J. B.	879
Sewall Co., James W.	872
Silva	876
Smith, A. R.	869
Smith Co., D. B.	2nd Cover
Southern Coatings & Chemical	853
Southern Seed Co.	859
Southern Timber Mgmt.	872
Stainer, Julius	877
Stock, John W.	874
Suncrest Evergreen	857
Timber Mgmt. Service	873
Tree Farm Mgmt.	874
Viking Trading	857
Wenzel Co.	876
Western Fire Equipment	875
Weyerhaeuser Timber	871
Wolff, Wm. J.	857

agencies. A 200-page report was prepared presenting relevant statistics on the state's 14 watersheds, and offering concrete plans which, in conjunction with sound forestry and soil practices, may become the basis for long-range water conservation projects.

Douglas-fir Forest Soils Committee Holds Summer Field Meeting

Members of the Forest Soils Committee of the Douglas Fir Region participated in the Soil Science Society of America annual meeting at the University of California, at Davis on August 15 through 18th. Following presentation of papers and symposia on forest soil and watershed management problems, the group assisted in conducting field tours in central and northern California and western Oregon. The California itinerary under the direction of Robert A. Gardner and A. E. Wieslander of the California Forest and Range Experiment Station and Lee Burcham of the California State Division of Forestry included wildland soil problems of the woodland-grass zone and the second-growth ponderosa pine type of the Sierra foothill region, the Institute of Forest Genetics and the coast redwood forests of northern California. Procedures, techniques, and results of the intensive soil-vegetation surveys conducted cooperatively by the California State Division of Forestry and the U. S. Forest Service were reviewed.

Committee members from the Northwest sponsored and conducted the tour through western Oregon. Inspections of forest soils were made in the coast range of southern Oregon, the high Cascade mixed conifer type (sugar and ponderosa pine, Douglas-fir, white, noble and Shasta fir), the central Oregon ponderosa—lodgepole stands and the Douglas-fir—western hemlock old-growth stands of northwest Oregon. Dr. C. T. Youngberg, Oregon State College and Robert Tarrant, Pacific Northwest Forest Experiment Station led discussions on the problems created by recent lava flows and deposits and complex geological formations such as the serpentine soils and parent rock, and the pumice soil mantle which often contains rocks so light they float in water.

Soil science and forestry specialists from several foreign countries and other U. S. regions made the tour. Stops of special interest to them were made in the California redwood state parks, Southern Oregon College of Education where Dr. E. N. Stevenson, president, discussed the geology of the region, Crater Lake, Pringle Falls, and H. J. Andrews experimental forests. The motor caravan covered over a thousand miles of forest and wildlands and emphasized the need for more survey inventories of soil and vegetation conditions and for additional research funds and personnel.

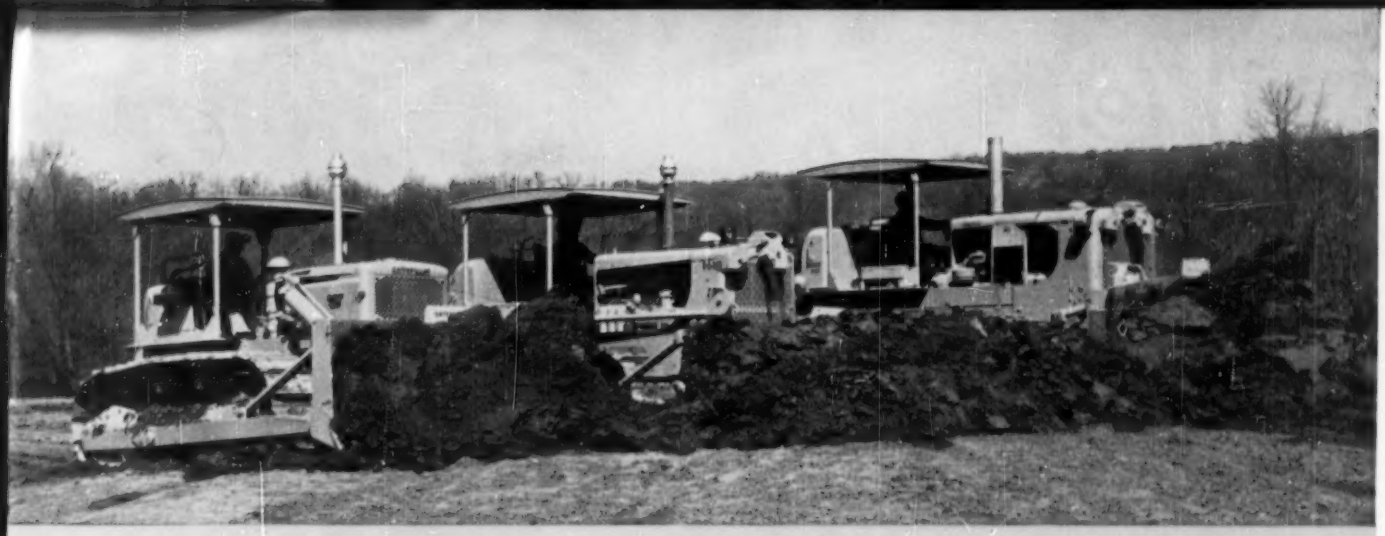
Oregon Saw Chain Corp. Occupies New Plant

Oregon Saw Chain Corp., Portland, Oregon saw chain manufacturing firm, is now in full production in its new 66,000 square foot factory at 9701 S. E. McLoughlin Boulevard.

Complete manufacturing, engineering, storage and office facilities, as well as adequate space for future expansion, have been provided in the air-conditioned building. Manufacturing and office equipment has been supplemented by new machines and tools. Comfort of personnel, as well as manufacturing facility, was a major consideration. The entire second floor is devoted to an employee recreation and lunch room, with an open patio. Office and recreation room walls are finished in hemlock, fir, and other native woods. Perennial plants and native stone have been used in landscaping the plant grounds and ample parking space has been provided.

The plant is the fourth of four factories Oregon Saw Chain Corp. has occupied since the company's four original employees produced the first Oregon Chain in 1947. Current personnel is in excess of 250, and 6,700 dealers and distributors now handle Oregon products in the world's timbered areas. The company produces a complete line of Oregon Chipper, Chisel and Crosscut chains for all makes and models of chain saws, Oregon Chipper Chain being used as original factory equipment by 37 of the 41 American and Canadian chain saw manufacturers. Other Oregon products are Armor-Tip saw bars, sprockets, file holders, chromed files, depth gauges, chain breakers, bar regroovers, outer-end handles, and magnesium wedges.

The Oregon Saw Chain Corp. factory in Portland, and a new factory now being constructed by an affiliate company, Oregon Saw Chain Ltd., at Guelph, Ontario, are the only plants in the world devoted exclusively to the large scale manufacture of saw chain and chain saw accessory and maintenance equipment.



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See your dealer for details on the Homelite TIME PAYMENT PLAN

Packed with power, the new Homelite Model 5-20 Chain Saw brings down big trees six feet in diameter, cuts through 20" trees in 20 seconds without forcing or jamming. Anyone can operate it . . . no experience necessary.

Interchangeable Blades add versatility to the new Homelite 5-20 Chain Saw. For felling, bucking, limbing or plunge cutting, there's a hard track blade for every requirement. Straight blades available from 14" to 60", bow saws 14" and 18".

Bucking is easier on man and saw when a Homelite 5-20 goes to work. Takes less time than ever before. The 5-20 stands up under the grind on any job . . . job after job.

Underbucking takes less effort and is just as simple as bucking. The 5-20 is easy to handle upside down or in any position . . . and there's no loss of power.

HOMELITE

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Manufacturers of Carryable Chain Saws • Pumps Generators • Blowers